U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE STATE OF WASHINGTON, ERNEST LISTER, GOVERNOR; HENRY LANDES, STATE GEOLOGIST.

SOIL SURVEY OF SPOKANE COUNTY, WASHINGTON.

BY

CORNELIUS VAN DUYNE, IN CHARGE, AND H. C. MORTLOCK, OF THE U. S. DEPARTMENT OF AGRICULTURE, AND A. F. HECK AND E. D. ALVORD, OF THE WASHINGTON GEOLOGICAL SURVEY.

MACY H. LAPHAM, INSPECTOR, WESTERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1917.]

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LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., March 25, 1920.

SIR: I have the honor to transmit herewith the manuscript report and map covering the soil survey of Spokane County, Wash., and to recommend that they be published as advance sheets of Field Operations of the Bureau of Soils, 1917, as authorized by law. This work was done in cooperation with the State of Washington.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. E. T. MEREDITH,
Secretary of Agriculture.

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MAP.

SOIL SURVEY OF SPOKANE COUNTY, WASHINGTON.

By CORNELIUS VAN DUYNE, In Charge, and H. C. MORTLOCK, of the U. S. Department of Agriculture, and A. F. HECK and E. D. ALVORD, of the Washington Geological Survey.—Area Inspected by MACY H. LAPHAM.

DESCRIPTION OF THE AREA.

Spokane County lies in the extreme eastern part of Washington, bordering the State of Idaho. It has a maximum length north and south of 54 miles, and a maximum width east and west of 36 miles. The boundaries consist almost wholly of township and range lines, except for the northern part of the western boundary, where the line is purely arbitrary and for a 20-mile section of the western part of the northern line, where the Spokane River forms the boundary. The county has a land area of 1,756 square miles, or 1,123,840 acres.

The base map used in this survey is compiled from U. S. Geological Survey quadrangle sheets and U. S. Land Office plats. The former include the Spokane and Oakesdale quadrangles, enlarged, and cover all the eastern two-thirds of the county except a strip about 3 miles wide along the north line. The remainder is covered by U. S. Land Office plats.

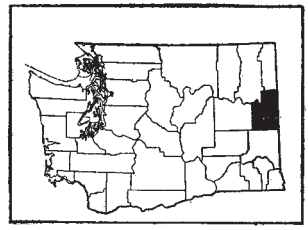


FIG. 1.—Sketch map showing location of the Spokane County area, Washington.

Spokane County lies within two well-defined physiographic and geologic provinces of eastern Washington, viz, the Okanogan Highlands and the Great Plain of the Columbia River. The former comprises the hilly to mountainous areas of the eastern part of the county, underlain chiefly by granitic rocks, while the latter includes the level to rolling portion of the county underlain by basalt. On the basis of topography the county includes five divisions, viz, mountainous areas, strongly rolling to hilly areas, rolling prairie, undulating plains underlain by basalt, and broad alluvial belts.

Topographically the area consists in general of hilly to mountainous country in the northeastern part and undulating to hilly country over the most of the rest of the area. There are two areas of hilly to mountainous country; one in the northeastern part of the county including all of Ts. 27, 28, and 29 N., R. 45 E., most of Ts. 27 and 28 N., R. 44 E., and parts of T. 26 N., Rs. 44 and 45 E., with small areas in adjacent townships. The other area includes practically all of T. 24 N., Rs. 44 and 45 E., with considerable areas in the adjacent townships

on the west and north. The central part of each of these areas consists of a mountain spur extending across the county line from the higher mountains of Idaho. Fringing the high central portion there is a belt of hilly country grading down into the surrounding lower country. Immediately adjacent to the Spokane River below Spokane there is a very narrow belt of rough country and a small area extends into the county in T. 27 N., R. 42 E.

The rest of the area is relatively smooth, consisting of an area of rolling prairie covering eight of the southeastern townships and portions of adjacent ones, an area of about 40 square miles in the western parts of Ts. 25 and 26 N., R. 40 E., and small areas elsewhere in the southwestern part of the county.

The western half of the northern part of the county, to which may be added a belt extending from Spokane eastward between the two mountainous areas to the State line, consists of a rather rolling forest-covered area. While the southwestern part of the county has a lower relief than the northwestern, in minor detail there are many inequalities. It is a forest-covered area and has in general a shallow soil.

Spokane County is drained by two principal streams, the Spokane River and the Palouse River, the drainage waters ultimately flowing into the Columbia River. Approximately 400 square miles in the southwestern part of the county lie within the basin of the Palouse River. The greater part of this drainage is internal. All the streams except North Pine Creek are intermittent, and many of them carry water only after the sudden thawing of snow. Others are fed by springs and flow for short distances before the water disappears. None of the drainage ways have reached base level, and North Pine Creek is the only one with a definite valley. There are numerous poorly drained depressions.

The Spokane River drains the remainder of the county. Practically all of the drainage reaches the perennial streams of this system through springs, as there is little run-off at any time of the year. The Spokane River has only two really perennial tributaries, Little Spokane River from the north and Latah or Hangmans Creek from the south. The former drains the entire northern extension of the county through Dragoon, Dry, Deer, Deep, and Deadman Creeks. These creeks have deep, V-shaped valleys and numerous tributaries in the hill section, but upon emerging to the terrace region they become deeply intrenched and receive no further contributions from surface streams. Although none of the streams have reached base level, they are doing almost no cutting down at the present time. Latah Creek drains all the southeastern part of the county, but during the greater part of the year it discharges very little water into the Spokane River.

The lakes of the county are of two classes, those held in place by gravel dams, as Newman, Liberty, and Eloika Lakes, and those occupying fairly well-defined rock basins, such as Williams, Badger, Chapman, and Calvert Lakes. The latter are found in the southwestern part of the county.

Plants at Spokane, Ninemile Falls, Long Lake, and Little Falls, all on the Spokane River, generate more than sufficient hydroelectric power to meet the demands of the county. There are power possibilities along the Little Spokane River which have not been developed.

Permanent settlement of this county dates from the early seventies. Spokane County was organized from a part of Stevens County in 1879. The Northern Pacific Railroad was completed into Spokane, which then had a population of about 1,000, in 1881. Development has been closely linked with railroad building, which was most active between 1885 and 1895.

As the county was within the land grant of the Northern Pacific Railroad, only every alternate square mile was open for homestead entry, but railroad land was available for purchase at a nominal price. The early inhabitants were trappers, miners, railroad men, and stockmen, mainly from the northern-central States.

The population of Spokane County increased from 4,262 in 1880 to 37,487 in 1890 and 139,404 in 1910. In 1910 the census classed 107,678 of the population as urban and 31,728 as rural, the latter including all places with less than 2,500 inhabitants. The city of Spokane, with a population of 104,402, and Hillyard, with 3,276 inhabitants, made up the urban population. The rural population averaged about 18 persons per square mile in 1910. There are several quite densely populated rural sections, mainly in the Spokane Valley, and the rural population as a whole has been steadily increasing, though not so rapidly as has the urban. In some sections the rural population shows a decrease. The "Palouse country," in the southwestern part of the county, is rather thinly settled.

Spokane, the county seat, is the second largest city in the State and the largest within the territory widely known as the "Inland Empire." Main lines of four transcontinental railroad systems enter this city, and with several branch roads and electric lines make it a very important railroad and distribution center. It is a shipping and marketing point for a large surrounding territory. Packing houses, canning factories, and brick and tile works are among the industries of Spokane.

Hillyard is a railroad town surrounded on three sides by the city of Spokane. Medical Lake, with a population in 1910 of 1,730, is the next town in size. It is situated in the west-central part of the county.

Cheney, with a population in 1910 of 1,207, situated about 15 miles southwest of Spokane, is a distributing, marketing, and educational center. The largest town in the northern part of the county is Deer Park, whose population in 1910 was 875. It is a locally important marketing and shipping point. In the southeastern part of the county the principal towns are Rockford, Latah, Waverly, and Fairfield, each with a population between 300 and 700 in 1910.[1] There are numerous other marketing and shipping towns in all sections of the county.

Spokane County has nearly 350 miles of railroad, which give satisfactory facilities over a large part of its area. Main lines of the Northern Pacific, Great Northern, and Chicago, Milwaukee & St. Paul Railroads between Chicago, Minneapolis, and St. Paul and the Pacific Coast pass through Spokane. Lines of the Oregon-Washington Railroad & Navigation Co., and the Spokane, Portland & Seattle Railway operate between Portland and Spokane. The former system also has lines from Spokane, via Rockford, Fairfield, and Latah, to southeastern Washington, Idaho, and Oregon and also to Harrison, Wallace and other Idaho points. The Palouse Branch of the Northern Pacific Railroad leaves the main line at Marshall and continues southward to a number of Washington and Idaho points. The main line of this system affords service to Coeur d'Alene and other places in Idaho. Its Washington Central Branch extends northwestward from Cheney to central Washington points. The Spokane Falls and Northern branch of the Great Northern Railroad gives communication with northeastern Washington and with points in British Columbia. The Spokane International Railroad extends eastward through the Spokane Valley and gives freight and passenger service to a number of places in Washington and Idaho.

Several interurban electric lines give good local service. One branch of the Spokane & Inland Empire Railroad follows the Spokane Valley eastward from Spokane through Millwood, Greenacres, and Spokane Bridge, while another extends along the south side of the same valley through Dishman, Opportunity, and Vera. A third extends south through Freeman and Waverly to Spring Valley, where it divides, one branch continuing to Colfax (Whitman County) and the other to Moscow, Idaho. Another interurban line runs from Spokane to Cheney Junction, Medical Lake, and Cheney.

The county has a rather extensive public road system which fairly adequately covers all except the high, hilly, and mountainous sections in the eastern and northeastern parts. In some places the roads follow section lines and in others the drainage courses. The poorest

[1] Since this report was written the preliminary announcement of the population of Spokane County and its civil divisions in 1920 has been issued by the Bureau of the Census, as follows: Spokane County, 141,289; urban, 108,379; rural, 32,910; Cheney, 1,252; Deer Park, 1,103; Fairfield, 413; Hillyard, 3,942; Latah, 330; Medical Lake, 1,254; Rockford, 435; Spangle, 291; Spokane, 104,437; Waverly, 234.

roads are found in the southwestern part of the county. There are several well-improved roads, among which are the Palouse and the Inland Empire Highways to the south, the Colville Road and the State Road through Chattaroy to the north, the Sunset Boulevard to the west, and the Apple Way and the Trent Road eastward through the Spokane Valley. The rivers and creeks are all well bridged. There is an abundance of good road-building material in the county.

Rural mail-delivery routes reach practically all except the rough and thinly settled sections of the county. Telephone lines extend to to all the well-settled sections and to some of the remote districts. All of the small towns are lighted by electricity.

The city of Spokane is a good market for orchard fruits, small fruits, potatoes, and all truck crops. Dairy products are sold locally and also in Spokane. Wheat is sold at the local towns and to numerous storage warehouses along the railroads within the wheat-growing sections. The crop is ultimately shipped to Seattle or Portland. The mining districts of Idaho and Montana are supplied in part by agricultural products from this county. Fruit-packing houses are located at sidings in the various fruit districts, and the fruit is marketed through a fruit-growers' association.

CLIMATE.[2]

GENERAL CLIMATIC CONDITIONS.

The location of this area on the western slope of the Coeur d'Alene Mountains in the eastern part of the Columbia River Basin gives it a climate with many characteristics of the continental interior and entirely different from that of western Washington, only 200 miles distant. The moderating influence of the westerly winds from the Pacific Ocean which are such an important factor in the climate of western Washington is only slightly felt in this section, on account of the high Cascade Range to the west. Although protected to some extent by the Rocky Mountains and the Selkirks from the cold northerly and easterly winds, it lacks the additional protection afforded by the Cascade Mountains, and is therefore much more subject to continental extremes of climate than portions of the State lying west of that range.

Its location on the westward-facing slope of the Coeur d'Alene Mountains gives this area a more abundant rainfall than the central part of the Columbia River Basin, but it does not approach in amount the rainfall of the greater part of western Washington. The moist air moving in from the Pacific Ocean loses much of its moisture when forced upward in passing over the Cascade Mountains, and in descending on the eastern slope it is dynamically warmed so that it moves

[2] This chapter written by Prof. E. J. Saunders, of the University of Washington.

over central Washington as a dry wind able to take up moisture rather than cause precipitation. When, however, it is forced to ascend the slope toward the Coeur d'Alene Mountains in this section of the State, increased precipitation results. The 20-inch annual rainfall line which is the boundary between what is called the dry belt of central Washington and the moist belt of Eastern Washington, passes through the eastern part of Spokane County.

In preparing the sketch maps to represent climatic conditions, so few stations with long-period records were found in Spokane County that it was necessary to use the data from stations throughout northeastern Washington and in the western part of Idaho to give any adequate idea of general climatic conditions in this particular area.

PRECIPITATION.

The average annual precipitation for the stations in and about Spokane County is shown in figure 2. The rainfall increases from 10 inches in the southwestern part of the area in irregular belts eastward to 24 inches at some of the stations in Idaho nearest the eastern border of the area. The precipitation in Spokane County varies from less than 16 inches in the southwestern corner to more than 22 inches in the northeastern corner of the county, while the average is well represented by the figure for Spokane, which is 17.60 inches. The variation in precipitation for various stations is shown in the following table:

Maximum and minimum precipitation for various stations.

Station and county.	Maximum.	Year.	Minimum.	Year.
	Inches.		*Inches.*	
Colville, Stevens County	32.83	1875	8.84	1873
Northport, Stevens County	24.93	1900	15.10	1910
Spokane	25.99	1882	11.86	1911
Wilbur, Lincoln County	18.20	1906	7.99	1911
Republic, Ferry County	19.07	1900	10.71	1910

The low annual precipitation here, as compared with 20 to 60 inches in the Puget Sound Basin and 100 inches on the western slopes of the Cascade Mountains, less than 250 miles west of this section, is explained by the fact that eastern as well as western Washington depends on the moisture-laden winds from the Pacific Ocean for its supply of rain and snow. The warm, moist air, traveling eastward as a part of the general eastward drift, or more commonly moving into the cyclonic storms, is cooled to such an extent by forced ascent in passing over the Cascade Mountains that the greater part of its moisture is deposited on the western slopes. In descending the eastern slope it is dynamically warmed by increase of pressure at lower levels and its capacity for moisture rapidly increases, thus favoring clear

skies and scant precipitation. As a result of this change in relative humidity the annual rainfall decreases rather quickly as the air

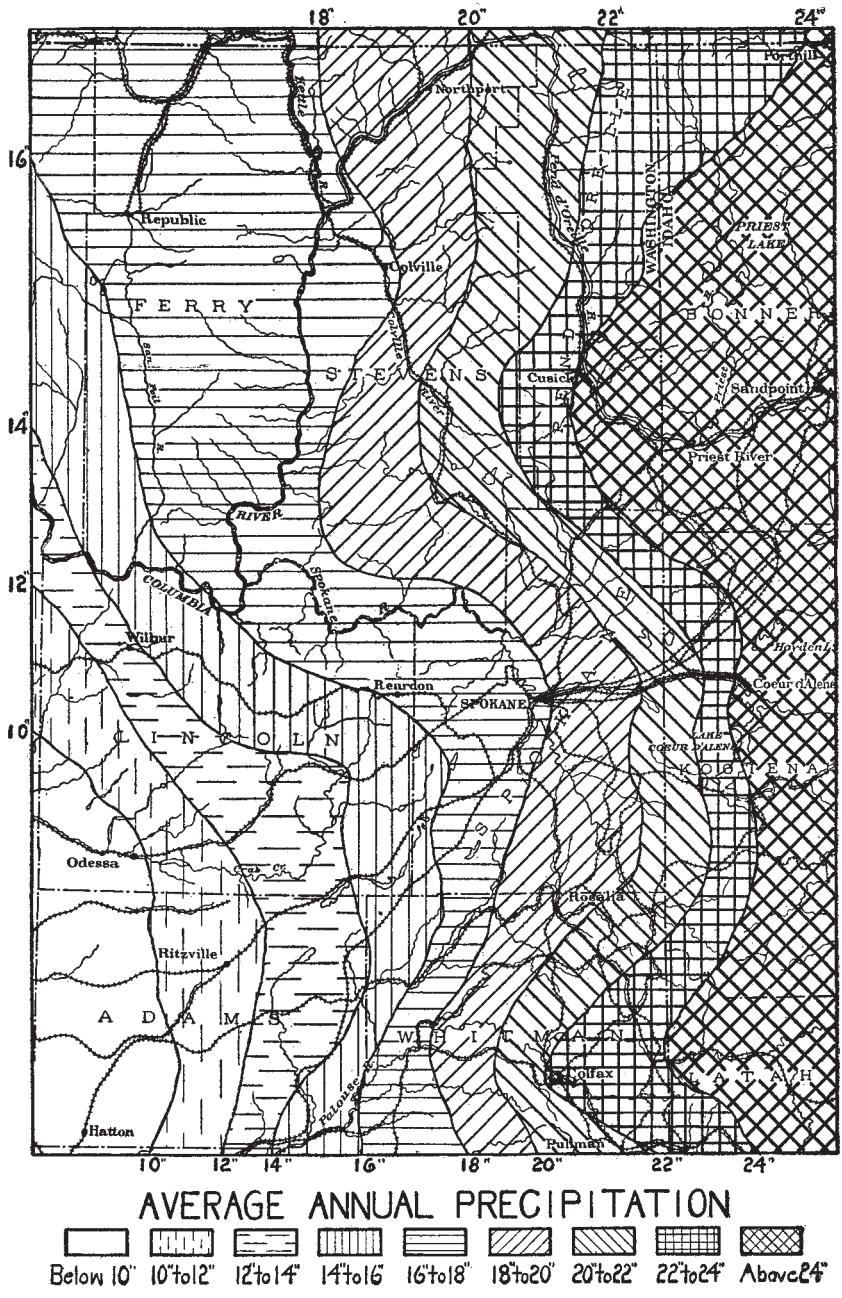


FIG. 2.—Sketch map showing average annual precipitation.

moves toward the Columbia Valley, and again increases gradually as the air is forced to higher levels in moving up the slopes toward the

Coeur d'Alene Mountains, having collected moisture in its journey through the Columbia River Valley. This causes the increase in irregular belts from west to east, as shown (fig. 2), and if longer-period records for a greater number of stations were available, a much

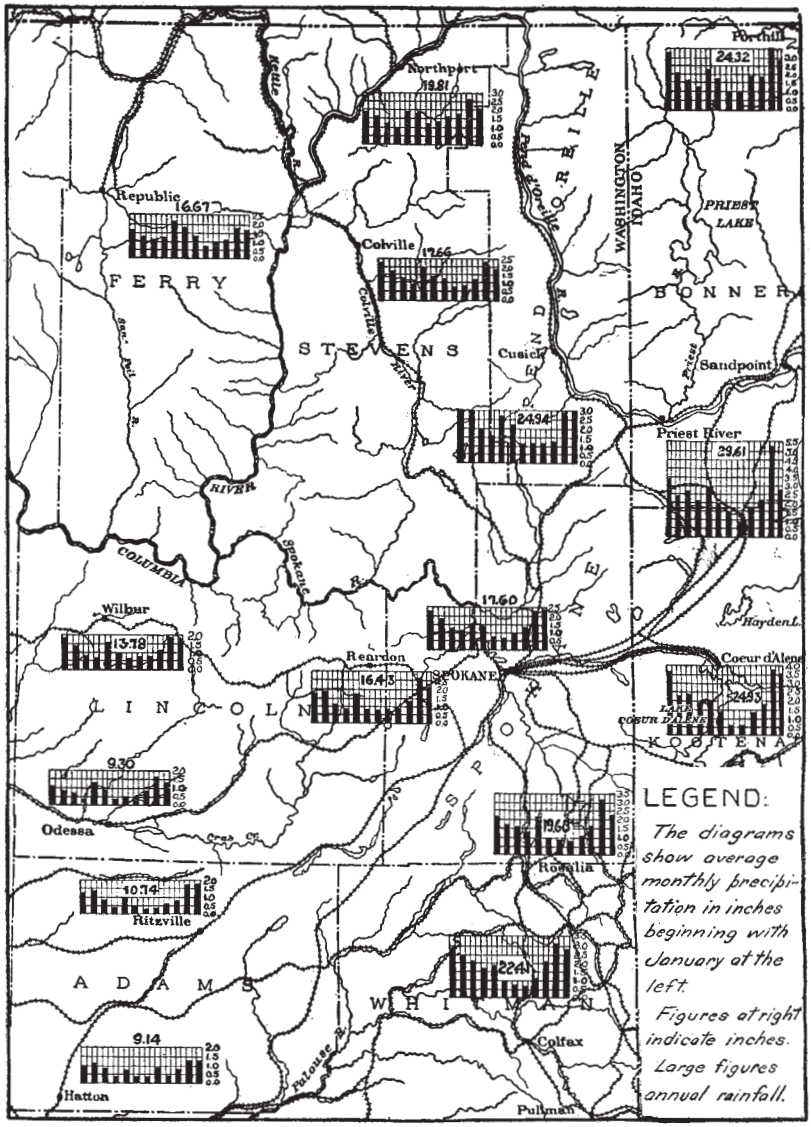


FIG. 3.—Diagram showing average monthly precipitation.

more marked effect of increase in elevation and general topography than is here shown would probably be found.

The monthly distribution of rainfall at the various stations is shown in figure 3. The effect of the proximity of the western coast

is evident in the decided winter maximum of precipitation, dividing the year into a wet season from October to March, inclusive, and a dry season from April to September, inclusive. But the contrast between the two seasons is much less marked than in western Washington.

With a normal annual precipitation of about 18 inches at Spokane, the total for 6 months, October to March, inclusive, is 12 inches, and for 9 months, October to June, inclusive, it is 16.50 inches. While for Seattle with a normal of 34 inches the total for 6 months is 25.15 inches, and for 9 months, 31.08. For the 3 months July to September, inclusive, the total precipitation at Spokane is 2.16 inches, while at Seattle it is only 2.75 inches.

The winter maximum is accounted for by the greater intensity and frequency of the cyclonic or storm areas during the winter months, and the movement of the moist air from the warmer ocean over a cooler continent. Even after its passage over the Cascade Mountains it is cooled again as it ascends in its movement eastward over this section, and thus yields additional precipitation.

A very noticeable secondary maximum occurs in May and June in most cases not so high as the November, December, and January precipitation, but higher than the other spring and summer months. This is a matter of great interest to the agriculturist as it furnishes the much needed rain in the growing months. At Spokane, for instance, there is an average total precipitation for May, June, and July of 3.66 inches or over 1 inch per month, July showing the least, about 0.67 inch. This is accounted for by the rather common heavy summer showers, thunderstorms, or even "cloud-bursts," so-called, that occur during or near the close of a prolonged warm spell as regular convectional storms. These showers bring the summer average up much nearer the winter average than for stations west of the Cascade Mountains. On the other hand, the early spring and summer maximum is characteristic of all stations east of the Rocky Mountains in the continental interior, where the summer precipitation is always greater than the winter precipitation.

In this section, then, there is evidence of two distinct controls, the oceanic or west coast, which is characterized by a winter maximum of precipitation, and the continental or interior, with a decided summer maximum, the former in this case being slightly more pronounced in its effects because of the proximity to the Pacific coast.

SNOWFALL.

The average snowfall throughout the area covered by the precipitation maps varies from 27.3 inches at Wilbur to 40.4 inches at Colville, and 58 inches at Northport. The absolute annual maximum for recorded years varies from 44 inches at Wilbur to 74.6 inches at Colville, and 99.5 inches at Northport. The average snowfall for

Spokane is 38 inches for the winter season. The lowest ever recorded was 11.1 inches in the winter of 1904–05 and the highest recorded was 79.1 inches in the winter of 1889–90. Since 1885 seven winter seasons show snowfall above 50 inches. While it remains on the ground for several weeks, it seldom attains a depth at any one time to seriously interfere with transportation. Occurring in the winter months, it serves as a protective blanket during the severe cold spells to which this section is subject and prevents the freezing of the roots of trees and plants. Melting in the spring, it supplies moisture slowly enough to be absorbed and retained by the soil and vegetal cover, furnishing an abundant supply of moisture when most needed by plant life.

Another very important factor in the climate of this area, especially in the ripening of grains and fruits, is the large number of clear days in the year. The Weather Bureau records for Spokane show an average of 97 clear days, 111 partly cloudy days, 157 cloudy days, and 120 days on which the precipitation is more than 0.01 inch. This means a year with about 208 more or less sunshiny days and only 120 days on which precipitation occurs, as compared with 106 more or less clear days and 147 days with precipitation, in the Puget Sound district.

Table of climatic data.

Station.	Elevation in feet.	Snowfall in inches.	Days with rain, 0.01 inch or over.	Cloudy days.	Partly cloudy days.	Clear days.	Average July temperature.	Average January temperature.	Average last killing frost.	Average first killing frost.	Days without frost.
							° F.	° F.			
Wilbur	2,203	27.3	72	133	72	160	64.7	23.7	June 18	Sept. 15	89
Republic	2,628	45.3	89	122	60	183	64.6	24.7	June 15	Sept. 3	80
Colville	1,635	40.4	91	138	64	164	68.1	21.9	June 5	Sept. 7	94
Northport	1,350	58	117	120	107	138	67.5	21.2	June 11	Sept. 9	90
Spokane	1,943	37.5	116	157	111	97	68.8	26.7	Apr. 11	Oct. 12	184

TEMPERATURE.

The mean annual temperature in this section varies from 43° F. for the northern to 49° F. for the southern stations. The mean annual temperature for Spokane is 48.1° F. In this case, even more than in the case of precipitation, more comprehensive data would probably indicate a wider variation on account of the irregular topography.

The range between the coldest and warmest month is 46.2° F. at Colville, or from 21.9° F. for January to 68.1° F. for July, as compared with a range of 20° F. in western Washington, or from 40° F. in January to 60° F. in July. The average for the coldest month varies from 21.9° F. at Colville to 26.7° F. at Spokane and 31° at Colfax. For the warmest month the average varies from 68.1° F. at Colville to 68.8° F.

at Spokane and 64.8° F. at Colfax. This gives a mean annual range of temperature for Spokane of 42.1° F. or from 26.7° F. for average January temperature to 68.8° F. for average July temperature. The average range between maximum and minimum temperatures recorded each year at Spokane is 106.8° F.

The absolute range of temperature since 1882 is 134.5° F., 104° F. being recorded in 1898 and —30.5° F. in 1888. Only 11 years in this period show temperatures of 100° F. or over and only 4 years in which temperatures below —20° F. are recorded. These extremes are thus not at all common in this area, and on account of the low relative humidity of the air, which is about 65 per cent, are not felt as they would be if the air were moist. During even the warmest summer weather the nights are pleasantly cool and during the coldest periods in the winter the days are bright, clear, and crisp.

The cold spells of the winter are the result of well-developed anticyclonic or high-pressure areas to the north and east of the section spreading out and sending cold air over this section in spite of the protection afforded by the mountains to the east. They are quite commonly followed by warm, dry winds from the southwest, known as "Chinooks," which break up the cold spell, melt the snow quickly, and often dry it up as it melts.

The daily range of temperature in this section is much greater both in summer and in winter than in western Washington, especially under anticyclonic conditions.

The explanation of the strong annual, monthly, and daily range of temperature lies in, first, the very slight moderating effect that the ocean winds exert here on account of the Cascade Mountain barrier to the west; second, the fact that this section is protected from the continental extremes only by the different ranges of the Rocky Mountains and is open to influx of air from the north; third, the air deprived of moisture allows of much greater radiation of heat during the nights and the winter, thus increasing the daily and seasonal variation. The effect of the Pacific Ocean winds is felt in the fact that neither the warm spells of summer nor the cold spells of winter are so prolonged or so frequent as in sections of the eastern interior at the same latitude

KILLING FROSTS.

From the dates at which the earliest killing frosts in the fall and the latest killing frosts in the spring have occurred at the different stations, the average dates at which frosts may be expected are worked out in a general way in figures 4 and 5. Since the date of first and last frosts for any year depends largely on the passage of a well-developed anticyclonic or high-pressure area, the actual date will vary from year to year. The irregularities in topography and the short-period records for many of the stations also cause many variations from these general frost belts.

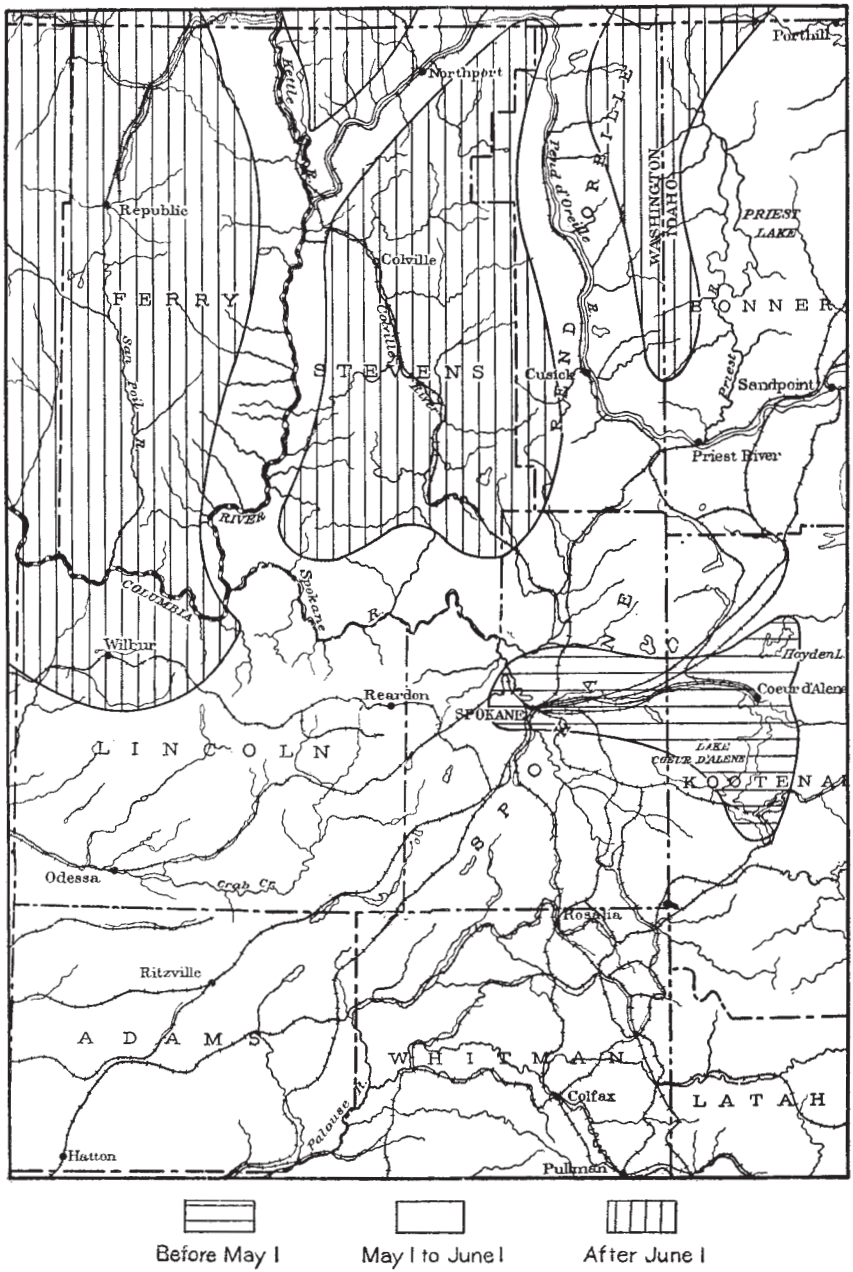


FIG. 4.—Latest killing frost in spring.

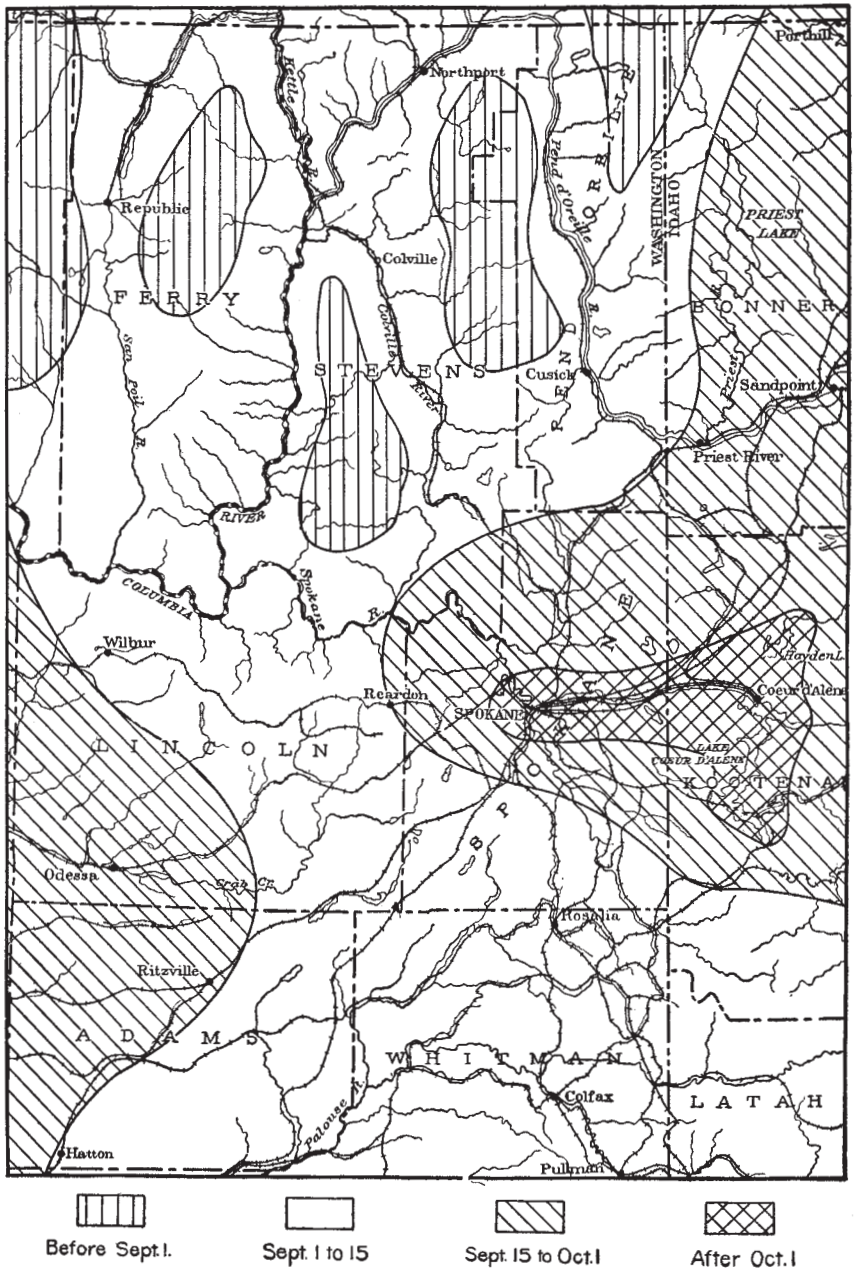


FIG. 5.—Earliest killing frost in fall.

One might suppose the uplands would be subject to frost earlier in the spring and later in the fall than the lowlands, but frequently the lower flat valleys have heavy frosts when the adjacent slopes and uplands are free from frost because of the drainage of cold air down the slopes to the valleys, where its collection, if outlet is not afforded, favors frost. Thus the terraces along the rivers often escape frost, while the bottom lands may be subject to severe killing frosts. The occurrence of frost pockets, where cold air collects, causing early and late frosts, is common in this section of irregular topography and causes many departures from the average conditions shown by the maps.

The average date for the earliest killing frost at Spokane is October 12 and for light frosts September 19. This means that killing frost may be expected any year about October 12. Killing frosts have occurred as early as September 7, but only seven times since 1882 before October 1, and in five years have not occurred until after November 1. Light frost is reported twice only before September 1.

The average date for the latest killing frosts in the spring is April 11, but killing frost has been reported once as late as June 8 and twice after May 1. On the other hand, seven years show no killing frost after March 20. The average date for last light frost is May 20, but light frost has been reported 10 times after June 1 and once as late as July 2.

The summary of the above statement is that, taking Spokane records as a basis, Spokane County enjoys a safe growing season from April 11 to October 12, about an even 6 months, or 184 days. Occasionally, however, this period is shortened by well-developed high-pressure areas causing early or late frosts, which can be predicted far enough ahead to enable agriculturists to employ different methods to protect their crops.

WINDS.

Owing to great topographic irregularities, the prevailing direction of the winds varies considerably for different stations as well as in different seasons. The main controls, aside from the topography, are the passage of the low-pressure and high-pressure areas, and the general eastward drift of air in this belt. In general, the winds are from a westerly quarter, southwest in some cases, northwest in others. At Colville, for instance, the prevailing direction for the year is southwest; at Republic it is northwest; at Spokane southwest; but at Wilbur in the winter months it is southeast and in the summer months it is southwest. The highest velocity recorded at Spokane is 52 miles, and that for a short time on only one occasion. Tornadoes are unknown, and thunderstorms are rare and seldom of violent type.

East winds are felt only occasionally, when a well-developed anticyclone to the east of the section causes the air to flow in from this

center of high pressure. Coming from the northeast in the winter, these winds usually cause a cold wave, and coming from the southeast in the summer they are frequently the cause of whatever short hot spells this section is subject to.

SUMMARY.

The climate of this section of the State is the result of a combination of oceanic, continental, and mountain climatic characteristics. The high temperatures of summers, the low temperatures of winter, and the secondary maximum of precipitation in May and June are all characteristic of interior climate. The winter maximum of precipitation and the fact that the summer warm waves and the winter cold waves are not severe, nor of so long duration as farther east, are evidences of the oceanic influence. The clear, dry, exhilarating air, the strong mountain winds, and the increasing precipitation toward the north and east are the result of the location of the section on the westward-facing slope of the Coeur d'Alene Mountains.

AGRICULTURE.

Agriculture in Spokane County dates from less than 50 years ago and in most parts of the county from less than 25 years ago. Stockmen early recognized the grazing possibilities of the rolling prairie, or the "Palouse country." Few or no permanent settlements were made, the herds being moved from place to place with the season and with the character of the grazing. The cattle were driven to places having water transportation and shipped to Portland. As late as 1880 only about 7,000 acres were in cultivation, on 566 farms, and domestic animals represented 45 per cent of the value of all farm property, including land, buildings, and implements. Crops were produced mainly on a small scale, for home consumption.

Agricultural development at first was confined to the prairie regions, where the soil was more readily prepared for crops. In addition to the rolling prairie in the southeastern part of the county, local areas, such as Fivemile, Pleasant, Peone, Paradise, Moran, the Spokane Valley, and other prairies were placed under cultivation. Areas of scattered forest were settled next, and finally the more heavily wooded and hilly to mountainous sections. Agricultural progress has been slow in the forested country, as there was practically no market for wood products in the early days, and much of the forested country is still remote from transportation facilities. The extensive operations in railroad building during the 15 years beginning with 1881, when the Northern Pacific was built into this county, opened up large areas to settlement. The rapid settling of the county in the eighties was due mainly to the success in wheat growing.

At the beginning of settlement the county comprised public land, subject to homestead entry in 160-acre tracts or to leasing; railroad

land, comprising every alternate square mile, subject to purchase or to leasing; and State land, including sections 16 and 36 in each township, subject to sale or to lease. In the prairie sections the public land was quickly homesteaded, and the railroad and State land purchased. The forested land did not pass so quickly to private ownership, but at the present time all except a small area of the mountainous land is owned by individuals or by lumber companies.

The number of farms in Spokane County increased from 566 in 1880 to 3,947 in 1910, while the average size decreased from 192 to 173 acres. In 1880 only 17 per cent of the land in farms was improved, as compared with 53 per cent in 1910. During the last decade many farms have been divided into small tracts for intensive cultivation, but to partly offset this a number of farms in the wheat country have been purchased and combined under single ownership. The large increase in the number of farms with the small change in the average size of farms indicates that development has consisted mainly of an extension of the farmed area rather than from the cutting up of large farms. There has been a great increase in the value of farm property, especially during the decade from 1900 to 1910. In the former year the average value of all farm property was $4,064 per farm, of which 71 per cent was represented by land, 13 per cent by buildings, 5 per cent by implements, and 11 per cent by domestic animals; while in 1910 the average value was $12,040, of which 82 per cent was comprised in land, 10 per cent in buildings, 2 per cent in implements, and 6 per cent in live stock. There has been a marked decrease in the relative value of domestic animals since 1880, in which year they comprised 45 per cent of the total farm values, or almost the same percentage as that of land, fences, and buildings combined.

A steady increase has taken place in the acreage and production of all the principal crops during the last 40 years, which comprises almost the entire period of agricultural development. The following table gives the acreage and production of the three leading crops at each of the last four census periods:

Acreage and production of the principal crops in Spokane County, 1880 to 1910.

Year.	Wheat.		Oats.		Hay.		All crops.[1]
	Acres.	Production.	Acres.	Production.	Acres.	Production.	
		Bushels.		*Bushels.*		*Tons.*	*Acres.*
1880	2,750	51,535	1,841	62,318	2,189	3,524	7,015
1890	33,857	568,292	10,887	271,384	33,015	36,279	99,763
1900	89,768	1,580,880	16,759	455,218	56,967	67,279	181,280
1910	93,295	2,378,446	45,479	1,890,823	58,718	89,001	223,560

[1] Does not include fallow land.

Some changes have taken place in the agriculture since 1880. No fruit trees were reported in this county in that year, but orcharding has since developed until a total of 418,556 trees were reported in 1910, and the last report of the State Department of Agriculture gives a total of 1,600,000 trees in orchards in 1915. A few years ago the sugar-beet industry developed into importance in the southeastern part of the county, but it has declined until practically no attention is given to beet growing. Stock raising has declined rapidly as the production of crops has increased, except in a few sections of the county where there has been an increase in live-stock and dairy farming in the last decade. About two-thirds of the total area of improved land, or about 33 per cent of the total area of the county, is used for annual farm crops. The remaining 67 per cent consists of summer fallow, pasture land, abandoned areas, and land still in forest. The greater part of the unimproved land is in the hilly to mountainous sections in the eastern and northeastern parts of the county. In the heavily wooded regions there are only two or three extensive clearings, the largest being on the Helmer silt loam in the vicinity of Freeman, Rockford, and Mount Hope, and others in the section surrounding Deer Park and between Half Moon Prairie and Dartford.

The principal sources of agricultural wealth of Spokane County are shown in the following table, which gives the acreage of crops by classes, the percentage of the cultivated area occupied by each class, and the income from each class of crops and from various live-stock industries. This table is compiled from the 1910 census, but the figures are representative of present-day conditions.

Income from the various classes of crops and from live-stock industries in 1909.

Class of crop.	Acreage.		Value.	
	Acres.	*Per cent.*	*Dollars.*	*Per cent.*
Cereals	143,732	64.2	2,823,814	43
Other grains and seeds	98	.1	15,002	.....
Hay and forage crops	58,718	26.2	1,203,351	18
Vegetables	12,493	5.5	543,563	8
Fruits and nuts	6,600	3.0	375,623	6
All other crops	1,919	1.0	344,762	5
Total	.....	.....	5,306,115	80
Live stock and products:				
Animals sold and slaughtered	.....	.....	518,841	8
Dairy products (excluding home use)	.....	.....	433,491	7
Poultry and eggs	.....	.....	368,949	5
Wool	.....	.....	1,013	.....
Total	.....	.....	1,322,294	20
Grand total	.....	.....	6,628,409	.....

Wheat is grown on practically every farm except in the irrigated and intensively farmed districts. It not only yields a large part of the farm income, but is also grown to supply feed and forage for stock. It is almost the only crop over large areas in the southeastern part of the county, and is grown on almost all the soil types. In 1909 the crop occupied over 40 per cent of the entire cultivated area, and a nearly equal acreage is usually kept in fallow for the succeeding year. Winter wheat is grown almost wholly on the originally forested terrace soils and on the upland in the northern part of the county, while both winter and spring varieties are grown elsewhere, the former occupying the larger acreage. Fields are seldom or never summer fallowed in connection with growing winter wheat in the wooded sections, while in the big wheat-producing prairie sections fallowing is almost universally practiced. Spring wheat generally follows fallowing or a crop of wheat or peas. Jones Winter Fife (red wheat) and Forty-fold or Gold Coin (white wheat) are the leading winter varieties, followed by Bluestem and Marquis. Jones Winter Fife is most popular in the northern and northwestern parts of the county, and Forty-fold in the "Palouse country." Yields of wheat range from 15 to 50 bushels per acre. The fields are given sufficient clean cultivation during the summer to destroy the weeds and to minimize the loss of moisture by evaporation. The seed is sown in September or October, or as early as the supply of moisture is sufficient for germination. The crop is harvested with a header, binder, or combined harvester, and is thrashed in the fields, sacked, and hauled directly to market. A scarcity of sacks is causing some farmers to adopt methods of handling the grain in bulk. A considerable acreage of wheat is annually cut green for hay.

Oats are grown quite widely, 45,479 acres in 1909 yielding 1,890,823 bushels, but are not a dominant crop in any section. They require considerable moisture, and as far as possible soils giving this condition are selected. Oats are grown on the dairy and stock farms and more extensively in the eastern than in the western part of the "Palouse country." In many cases oats and peas are sowed together, the crop being cut or thrashed. Oats yield 30 to 60 bushels per acre.

Barley was grown on 3,710 acres in 1909, producing 121,783 bushels. The acreage varies widely from year to year. Barley is grown mainly in the southern part of the county, part of the crop being used for feed and the surplus sold. Yields range from 10 to 60 bushels per acre, averaging about 40 bushels.

In 1909 there were 1,087 acres in corn, with a production of 30,355 bushels. The present acreage is not much greater. Corn is grown in small scattered fields, usually in a locality somewhat protected from late and early frosts. It is generally considered that the seasons are too short and the nights too cool for the profitable production of the crop.

The growing of peas for seed is a new industry in certain sections of the county, especially in the vicinity of Fairfield. Several thousand acres are devoted to this crop. It is grown under contract with eastern seed houses, at a fixed price per pound. About 75 pounds of seed are sowed to the acre. Yields in average seasons range from 30 to 40 bushels per acre, but they are sometimes lowered by dry weather. The crop is thrashed and the vines used for feed. After the peas are harvested the land is plowed as soon as possible and seeded the next spring to wheat, the pea crop taking the place of summer fallow. Peas are grown by many farmers for feeding purposes. The Bangalia seems to be the best variety for general farm use. Other varieties grown are the Amrioti, Alaska, Canada, and Kaiser.

Approximately 26 per cent of the cultivated area was devoted to hay and forage crops in 1909, and about 22 per cent of the value of all crops was represented by the production. Of the total area, 41,031 acres were in grains cut green for hay, which produced 63,561 tons. There were 15,879 acres in tame grasses, producing 21,492 tons. This included 14,042 acres of timothy alone, 769 acres of timothy and clover mixed, and 647 acres of alfalfa. The last-named crop is grown mainly under irrigation. The greater part of the hay crop is used at home, but there is an excess to sell locally in some seasons. Wheat and oats are often cut green for hay, and furnish by far the greater part of the hay and forage in the wheat-growing sections, where there is only a small acreage of tame grasses. Quite a large proportion of the timothy is grown on the Colville silt loam, dark-subsoil phase, and on the improved Muck and Peat areas. Frequently the narrow stream bottoms are used for hay production. The mixed timothy and clover is grown mainly in the northern part of the county. There are a number of silos in the county, which are filled with a variety of crops, including corn, oats and peas, clover, and vetch.

Potatoes are widely grown for home use, and many farmers have a surplus to sell. On some farms potatoes are one of the chief sources of income. The fields contain from 1 to 20 acres or more. The census reports 9,719 acres in potatoes in 1909, and the State agricultural report states that 162 carloads were shipped from the county in 1914. While the crop is grown mainly without irrigation, it is often produced under irrigation as on intertilled crop. Yields range from 100 to 300 bushels per acre. The Palouse fine sandy loam is one of the most important potato soils in the county. The crop is also grown commercially on the soils of the Garrison, Cheney, Palouse, and Springdale series. Burbank, Rural New Yorker, and Gold Coin are the leading varieties. The crop is planted as early as possible in the spring in a well-prepared seed bed in checks 3 feet

apart or in rows. Frequent level cultivation is given during the summer months. The greater part of the crop is dug by machinery. Potatoes are marketed in Spokane, from which place large shipments are made to outside points.

According to the report of the State department of agriculture covering a period ending June 30, 1916, Spokane is the third county in the State in number of commercial orchard trees, having 1,066,700 bearing trees and 533,300 of nonbearing age. Nearly 700,000 trees are in the Spokane Valley. At the present time there are approximately 10,000 acres of commercial orchard in the Spokane Valley, including several well-known districts, among which are Opportunity, Vera, Greenacres, Pasadena Park, Otis Orchards, and East Farms; 6,000 acres near Deer Park and Denison, embracing the Arcadia district; and 2,300 acres near Fairfield, Waverly, and Meadow Lake. The normal production of the Spokane Valley districts at the present time is about 1,000 cars, of the Deer Park district and vicinity 80 cars, and of the Fairfield, Waverly, and Meadow Lake districts 100 cars. The 1917 crop was short, and the Spokane Valley districts shipped approximately 350 cars, the Arcadia district 60 cars, and the Fairfield, Waverly, and Meadow Lake districts 60 cars.

The orchards in the Spokane Valley are almost wholly on the Garrison gravelly loam and at elevations ranging from 1,950 to 2,050 feet above sea level. They are irrigated either by gravity systems, the water being obtained from Newman and Liberty Lakes and from points farther up the valley, or by pumping from wells. In the northern part of the county the plantings are chiefly on the level to sloping soils of the Clayton and Springdale series and range from 2,100 to 2,200 feet in elevation. Irrigation is carried on by means of gravity systems from Loon and Deer Lakes (in Stevens County) and Dragoon Creek. In the vicinity of Fairfield, Waverly, and Meadow Lake the orchards are on the rolling prairie occupied by the Palouse silt loam and are not irrigated. Their elevation is from 2,300 to 2,700 feet. Less extensive orchard districts include those at Pleasant Prairie, Green Bluff School, Foothill, and Kiesling. In addition, many general farms have fairly large orchards and produce fruit commercially. Many small farm orchards produce fruit for home use.

The principal varieties of apples grown are the Jonathan, Rome Beauty, Wagener, Delicious, Grimes, Arkansas Black, and Banana, but there are many others. Most of the trees are between the ages of 3 and 15 years. Almost no plantings are being made at present. The orchards include the square, triangular, and hexagonal systems of planting. In the former the trees are set about 26 feet apart. In some cases the rows are spaced 28 feet apart with the trees 17

feet apart in the rows, the trees being of alternating varieties, with every second tree to be removed later. Other fruits are seldom planted as fillers in the orchards.

There is a great diversity in the methods of handling the orchards in the different sections of the county. Those on the Palouse silt loam are given clean cultivation without the growing of intertilled crops or cover crops. They are harrowed early in the spring and during the summer months to maintain a mulch and keep down the weeds. In some cases the orchards are thoroughly plowed and harrowed. In some of the other orcharding districts various crops are grown between the rows of trees, especially in the younger orchards, and this practice seems not to injure the trees. The intertilled crops are grown for market and for home use. They include potatoes, tomatoes, cabbage, carrots, onions, peas, beans, raspberries, strawberries, and blackberries. Alfalfa and clover are grown to a small extent, being seeded in strips between the rows. Wheat is sometimes grown in young orchards, but winter cover crops of oats, wheat, rye, and vetch are seldom used.

As a whole, the orchards are given good care. The trees are carefully pruned to low or medium heads. Spraying is carefully attended to and State inspectors enforce the strict laws in regard to the control and eradication of pests and diseases. No smudging is done to prevent injury by frosts.

In irrigated orchards in the Spokane Valley both surface and underground systems of distribution are used, the latter being most common where water is provided by pumping. The orchards are irrigated on the average about once a week from June 1 to September 1, and later in dry seasons. The water is usually conducted by three furrows between the rows of trees, the soils requiring an abundance of water. In the northern part of the county the orchards are irrigated about once a month during the summer. The quality of the water for irrigation is excellent. The supply by gravity systems is somewhat limited, though usually sufficient for the present acreage under ditch with careful conservation. The supply by pumping is obtained from wells in the glacial-terrace materials ranging from 50 to 100 feet or more in depth, and appears to be limited only by the cost of pumping. All the irrigated orchard areas have good drainage and there is no opportunity for the accumulation of alkali.

On the whole, the trees are making a satisfactory growth. They have a healthy color and produce a good grade of fruit when conditions are favorable. As the orchards are all young it is not possible to state the chances of profitable production as the trees become older. Orcharding is somewhat handicapped by the short season, as

a result of the rather high elevation, and some of the long-season varieties of apples are not profitably grown. The orchards on the rolling prairie sometimes suffer from a lack of moisture, which results in a smaller-sized and less highly colored fruit. Frosts sometimes decrease the yields of fruit, and occasionally freezes injure it before it can be picked.

Cherries, pears, plums, prunes, crabapples, and peaches are grown in small quantities for home use and for market. The production of small fruits is a source of income on many farms. Strawberries lead, occupying a total of 507 acres in 1909, and the State agricultural report states that 57 carloads of strawberries were shipped in 1915. The crop is grown chiefly without irrigation. The largest acreage is on the Green Bluff loam, a well-drained soil lying at about 2,400 feet elevation. They are also grown on the Palouse and Garrison soils. The county produces strawberries which come on the market late, and thus command good prices in local and outside markets. The single-row system of planting is followed. Among the varieties of strawberries grown are the Van Deman, Glenmary, Clark, and Marshall. The strawberry weevil gives the growers some trouble. The other berry crops are usually grown between the rows of trees.

Twenty per cent of the total value of all farm products in 1909 was represented by live-stock and animal products. Animals sold or slaughtered in 1909 numbered 3,097 calves, 4,782 other cattle, 19,963 hogs, and 952 sheep. The sale of live stock is a source of income on a large number of farms, but the chief source on comparatively few. As little or no corn is grown, wheat and wheat hay furnish a large part of the feed, and on account of the high price of feed the number of cattle and hogs on farms is being reduced.

According to the report of the State department of agriculture, Spokane County ranked second in 1915 in butter and milk production, the output amounting to 2,121,663 gallons of milk and 1,856,870 pounds of butter. A large part of this is needed to supply the city of Spokane. Dairying is not being extended much at the present time. The most important dairy district is the Scabland portion of the county, with its numerous small areas of hay and pasture lands. Several large dairies are located in the Little Spokane River Valley. A large number of farms make dairy products a minor source of income, and on some it is practically the only source of revenue. There are no creameries or cheese factories in the country districts. Many of the dairy farms are provided with modern equipment, and the cows are both grade and purebred stock.

In 1909 poultry and eggs brought in approximately 1 per cent of the total farm income for the county. Only a few farmers specialize in poultry raising, but local conditions are well adapted to this industry and its extension is warranted.

Physiography and topography exercise an important influence in determining the classes and varieties of crops to be grown as well as the sites to be chosen for fields and orchards. Crops not easily damaged by frosts, however, can be grown at least to as high elevations as the present farming area extends. Corn is not a popular crop on account of the cool nights and the short growing season, and these conditions also make it necessary to plant only such varieties of apples as are certain to mature. Topography has been an important factor in determining agricultural development, not through a tendency of any of the soils to erode where too steep but by limiting the use of farm machinery. The soils inclined to be droughty are used for winter wheat rather than for the spring varieties, and for early-maturing crops. It is recognized that the prairie soils hold moisture better than the forested types. The occurrence of areas of Colville silt loam, dark-subsoil phase, has determined the location of the dairy industry in the southwestern part of the county. The farmers recognize that the porous soils of the terraces are, in general, too droughty for late crops and are best adapted to winter wheat and to intensive crops. Oats are more widely grown in the eastern part of the "Palouse country" than in the western part, on account of the slightly greater rainfall.

The alternating of wheat and summer fallow has been the general practice in the Palouse country for years, both winter and spring wheat being grown in this manner. In some parts of the county wheat is alternated with peas. A few farmers follow wheat with barley and clover, and cut clover another year before the land is returned to wheat. There is a growing recognition of the need of some kind of a rotation even on the best soils.

Most of the farmhouses and other farm buildings in Spokane County range in quality from poor to fairly good, but there are some excellent homesteads on the best farms. Some of the dairy farms have excellent equipment. On the better class of farms the equipment is usually sufficient to perform operations with a minimum of labor. A few tractors are used for plowing, harrowing, and seeding. Farm machinery is well cared for on some farms, while on others no attention is given to its shelter. Some of the farms are well fenced. A fair grade of work horses and mules is to be found throughout the county. Automobiles are numerous, and trucks are used in many cases for hauling crops and wood to market.

The supply of farm labor is fairly adequate, except during the seeding, harvesting, and fruit-picking seasons, and the hands are usually efficient. Labor conditions are not uniform, owing to the contrasted rush and slack seasons and to the presence of a large city in the county. From $40 to $60 a month, with board, is often paid to farm laborers, and harvest hands are paid as much as $3 to $4 a

day. From $2 to $3 a day is the prevailing price for ordinary farm labor. The total expenditure for labor in 1909 was $815,129, or an average of $393.60 per farm for each of the 2,071 farms reporting an outlay. On many farms the work is done by the family or by exchanging work with neighbors. A total of only $3,489 was expended for commercial fertilizers in 1909 on 43 farms. On some farms, especially those in the forested regions, stable manure is the only fertilizer used. In the wheat-growing sections the straw stacks are frequently burned. The use of fertilizer is not increasing, as it is applied mostly to small, intensively farmed tracts. Very little lime is used.

The census of 1910 reports a total of 3,947 farms in Spokane County comprising 60.7 per cent of its area. The average size of the farms in that year was 172.9 acres. Approximately 53 per cent of the land in farms, or 91.7 acres per farm, was improved. In the territory immediately surrounding the city of Spokane and in the irrigated fruit districts the farms are small, frequently ranging from 5 to 10 acres in size. In the remainder of the forested portion of the county few farms exceed 160 acres. In the wheat-growing country and in the Scabland section in the southern part of the county the size ranges from 100 to 1,000 acres or more. In the northern part of the county considerable land is owned in large tracts by timber companies. In 1910, 83.2 per cent of the farms were operated by owners, 15.5 per cent by tenants, and 1.3 per cent by managers. The usual method of tenancy is the share system, but land near Spokane is often rented for cash.

In the southeastern part of the county, where uniform soil and other agricultural conditions prevail, the sale value of farm land is fairly uniform, but in some other sections, where there is a complex association of soil types varying in agricultural value and where the farms frequently contain more or less land that is too rough for farming there is a wide range in values. In the wheat-growing country the selling price ranges from $80 to upward of $150 an acre. In the irrigated fruit districts and in other intensively farmed sections, small tracts are valued at $300 to $500 an acre. Sales have been reported as high as $800 an acre, but not in the last few seasons. In the prairie sections of the basaltic plain or plateau, land values range from $100 to $300 or more an acre, depending upon the character of the soil, the state of cultivation, and the location.

SOILS.

Spokane County lies within the Rocky Mountain and the Northwest Intermountain soil regions, as defined by the Bureau of Soils (Bulletin 96). These regions closely conform to the physiographic provinces known as the Okanogan Highlands and the Great Plain of the Columbia.

The Okanogan Highlands division is underlain, in this county, mainly by old crystalline rocks of granitic character, except for a few miles along its northern border, where small areas of quartzite occur. Some areas of gneiss are also observable, especially on the south side of the Spokane Valley east of Spokane. It is probable that some schistose rocks occur in parts of the hilly region culminating in Mica Peak. There is some range in the character of the granitic rock, although a coarse-grained, gray granite predominates. In places it is traversed by numerous dikes of whitish rock. In some sections of the county it seems to carry little or no quartz, and approaches a syenite, weathering into a smooth silt loam.

The rocks of the Great Plain of the Columbia, coinciding with the so-called Northwest Intermountain soil region, are chiefly dark, heavy, fine-grained basalts occurring in layers or flows of varying thickness. In some places the rock shows a columnar structure, while in others it is fairly massive, or it may be very fragmentary. The surface of the individual layers frequently has a vesicular character.

The basalt abuts against the mountains of older rocks in the form of a horizontal rock terrace either dissected or undissected, extending along the line of contact from north to south. As a rule the basalt plain is dissected, leaving remnants, some of which consist of tongues of basalt which projected up the old valleys from the Columbia Plain. At the same time, isolated areas or outliers of other rocks are fairly common in some sections of the basalt plain. Granite rock outcrops in places from underneath the basalt in the valleys of the Spokane River and Latah and Coulée Creeks. More conspicuous still are the rounded hills which rise 100 to 300 feet or more above the level surface of the plain between Spokane, Cheney, and Medical Lake. A prominent hill lies to the west of the latter town, and two or more granitic hills occur in the northwestern part of the county. Tekoa Mountain and several other elevations of less prominence in the southeastern part of the county are largely made up of rocks other than basalt.

In the Pleistocene period this region was invaded by the glacial ice sheet, which covered large areas in the northern, central, and western part of the county. In contrast to conditions in Stevens County, where the ice covered all except the very highest elevations, it was here limited to elevations of less than 3,000 feet. The ice mixed the preexisting residual soils with glacially carried and glacially ground material derived from regions farther north. This was deposited on the retreat of the ice as glacial drift. Later some of it was removed by erosion or was covered by deposits of glacial-outwash material carried by streams flowing from the ice front. The drainage has begun to adjust itself and the streams to develop their present

valleys, but none of them has formed more than narrow areas of first-bottom or recent alluvial lands.

Over the basalt plain, especially in valleys in various sections of the county, there has been deposited fine-textured material free from gravel or rock fragments. This material was probably laid down in quiet waters caused by a temporary blocking of the drainage system. These deposits occur at several different levels. In addition, there is an extensive area of rolling country in the southeastern and eastern parts of the county and smaller areas elsewhere in which the soils are probably loessial in origin, at least in the surface material. This loess appears to have been deposited previously to the last invasion of the ice. Some of the sandy deposits of the glacial outwash and river terraces have, subsequently to their deposition, been modified and distributed by winds, and there are small but rather conspicuous areas formed mainly by the recent deposition of sediment and the accumulation of organic matter in lake basins and undrained, swampy depressions.

On the basis of origin and processes of accumulation of the present soil material, the soils of Spokane County may be divided into eight groups, as follows: (1) Residual soils, derived from the weathering of the underlying rocks; (2) soils derived from glacial drift; (3) soils derived from old water-laid material of the glacial lake and river terraces; (4) soils derived from wind-borne material; (5) soils derived from recent alluvial flood-plain deposits; (6) soils derived from recent sedimentary deposits of the glacial lake basins; (7) soils derived mainly from accumulations of organic matter; and (8) miscellaneous materials.

Each of these groups, except the last two, includes one or more series of soils. The series include a number of types, which are differentiated mainly on a basis of texture, determined by the relative proportion of the different-sized constituent particles. Soil types similar in color, character of subsoil and substratum, origin, and agricultural value in the same soil region are grouped together to form a series. The types within a series may range in texture from a stony or gravelly sand or sandy loam to a loam or clay. It usually happens that not all the members of a series are represented in any one survey. When essential similarity to previously recognized types is established the soils are correlated with established series and types. Minor variations in a soil type, if of sufficient extent and importance materially to affect the agricultural value, are recognized as phases.

Twenty series of soils, embracing 38 types and 18 phases, together with Muck and Peat and 4 classes of miscellaneous nonagricultural land, are recognized in the survey of Spokane County. Seventeen of the series were established prior to this survey. The distribution of

the soil types is indicated by means of colors on the accompanying soil map, and they are described in detail in subsequent pages of this report.

RESIDUAL SOILS.

The residual soils consist of more or less thoroughly disintegrated material derived from the underlying consolidated rocks, the depth of the soil depending upon the rate of weathering of the rocks as compared with the removal of the products through erosive agencies. Usually they are gradations in the material from fairly well decomposed soil through partially decomposed rock to unaltered bedrock, and the character of the parent rock frequently is readily ascertained from a study of the surface material.

This is a fairly extensive group of soils. They are derived largely from granitic rocks, but small areas of soil have come from quartzite or basalt. Gneiss and schist are unimportant soil-forming rocks in this county. The greater part of the soils of granitic origin belonging to this group occur within the high, rolling to hilly and mountainous divisions previously mentioned. Soils derived from basalt occur on the basaltic plain, and those from metamorphic rocks in the southwestern part of the county. Modifications due to other causes than differences in the parent rock have resulted in variations in the material, and the group includes both forested and prairie types. The soils of the residual group are classified into three series, the Moscow, Huckleberry, and Underwood.

The Moscow series includes forested soils derived from granitic rocks, including granites, mica schist, and gneiss. The soils range from light brown to brown in color, and have a friable structure. The subsoils range from yellowish brown or light brown to yellow, with gradations toward gray in the lower part of the 3-foot section. They may be loose or rather compact, but are friable in structure. The material is sometimes shallow, and outcrops of granitic rocks and small angular rock fragments are fairly common. The surface is hilly to mountainous, and drainage ranges from adequate to excessive.

The Huckleberry series consists of rich-brown forested soils with pale-yellow or yellowish-brown subsoils. The Huckleberry soils are derived to a large extent from partly metamorphosed or metamorphosed rocks, consisting mainly of partly altered sandstones and of quartzites. The series includes some sparsely forested or prairie areas. Chips and angular fragments of the parent rock are of frequent occurrence in these soils, often in large amounts. The soils are frequently shallow, and they are hilly and excessively drained.

The Underwood series includes forested soils which, where typically developed, have brown or reddish-brown surface soils and brown subsoils. They are derived from the weathering of the underlying basalt. As typically developed the soils have a hilly or mountainous topography, are fairly deep, and have small pellets or cemented

accretions in the surface soil and subsoil, but in this survey the series is represented by a variation in which the pellets are usually absent, the topography level though in detail irregular, the soil material very shallow, and the agricultural value low.

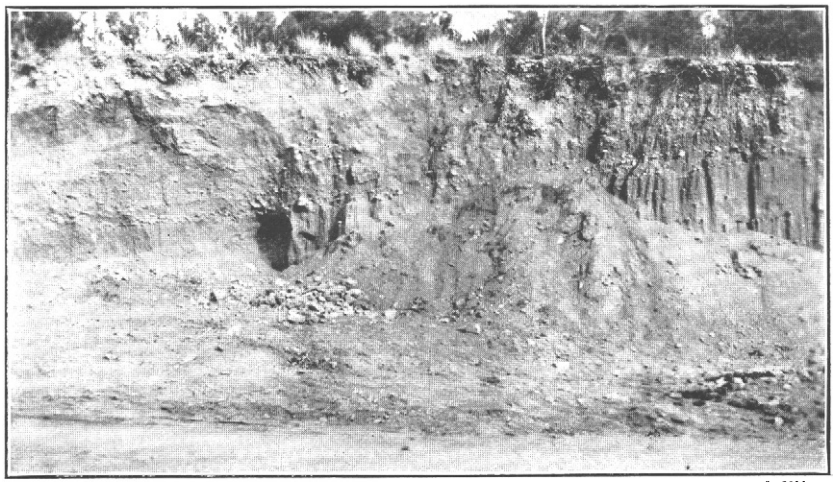
SOILS DERIVED FROM GLACIAL DRIFT.

The soils derived from glacial drift are found in the basaltic plain or plateau division, and to a less extent in the hilly section, of the county. They cover a considerable area, especially in the western part of the county. The material consists of unassorted deposits of fine earth, mixed with varying proportions of rock fragments or gravel, cobbles, and bowlders. The deposits are derived from both the preglacially weathered and the glacially ground rock material, and have been modified by weathering. The soils are usually related to the underlying rock. Both forested and prairie areas are included, and there is a color range from light yellowish brown to dark brown. This group of soils includes the Loon, Waits, Hesseltine, Cheney, and Green Bluff series.

The surface soils of the types included in the Loon series are light brownish yellow, with pale-yellow to brownish-yellow subsoils which become more grayish and looser with depth. Both soil and subsoil are friable. The Loon soils contain angular granitic particles and fragments and are underlain by granitic bedrock, which occasionally outcrops. They are derived from glacial till which, though probably originating from a variety of rocks, carries a high content of material of granitic origin. Bowlders are not usually abundant in the soils. The surface is rolling to hilly, and drainage is adequate or excessive.

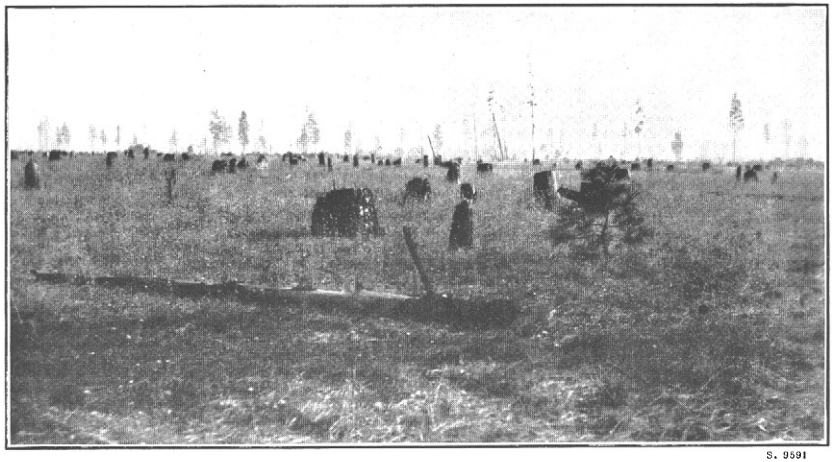
The members of the Waits series have light-brown to dark-brown surface soils and yellowish-brown or lighter brown subsoils. The stone content is variable and consists mainly of fragments of quartzite, which generally forms the bedrock. The material is fairly friable. The Waits soils are deficient in organic matter. Their topography ranges from rolling to hilly and rough. All of this land was once quite heavily forested.

The surface soils of the members of the Hesseltine series are brown to rusty brown or reddish brown, underlain by brown subsoils which are usually stony and consequently porous, causing excessive drainage. These soils occupy belts of the basaltic plain which have been traversed by tongues of glacial ice. They have a level to very gently undulating surface. Shallow glacial till derived mostly from basaltic rocks comprises the bulk of the soil material. The surface soil in some places is free from stone, and in others too stony for cultivation. Angular or irregular bowlders and fragments, as well as outcrops, of basalt are of frequent occurrence. The Hesseltine soils are characteristically forested with yellow pine or some other open growth, but in this county some treeless areas have been included.



S. 9634

FIG. 1.—CROSS SECTION IN SOILS OF THE SPRINGDALE SERIES, SHOWING SUBSTRATUM OF STRATIFIED GLACIAL OUTWASH SANDS AND GRAVELS.



S. 9591

FIG. 2.—CLEARING ON TERRACE OCCUPIED BY SOILS OF THE SPRINGDALE SERIES.

The Cheney series is the dark-colored prairie equivalent of the Hesseltine. The soils are dark brown or dark grayish brown in color, sometimes becoming nearly black when moist. They have a friable structure. The subsoils have a yellow to yellowish-brown color and are frequently quite stony. Outcrops of basalt sometimes occur in these soils. They are composed of thin, glacial ice-laid material derived mainly from basaltic rocks and later modified by accumulations of organic matter resulting from prairie conditions. These soils are well drained by means of percolation. The surface is generally level or gently undulating, with low, rounded knolls or ridges and intervening shallow flats or depressions.

The Green Bluff series includes soils derived from glacial drift of mixed rock origin. They are closely associated with the highest lying, old lake-laid material, which has probably contributed to their formation. The yellowish-brown or light-brown friable soils are underlain by a yellowish, fine-textured, stratified subsoil and substratum. This series is the freest from glacial bowlders and other rock fragments of all those derived from glacial till. The surface is elevated and undulating and internal drainage is adequate. The Green Bluff soils are underlain by basaltic rock. They are forested and low in organic matter.

SOILS DERIVED FROM OLD WATER-LAID MATERIAL OF THE GLACIAL LAKE AND RIVER TERRACES.

The glacial outwash and terrace soils may be divided into two groups, those of current-laid origin occupying terraces and underlain by porous deposits, and those of lake-laid origin occupying terraces and underlain by rather compact, fine-textured deposits.

The water-laid soils underlain by loose, porous deposits occupy terraces in the valleys of the Spokane and Little Spokane Rivers and a few of their tributaries. They occur mainly on the east side of the extensive valley trough in the northern and central parts of the county, and represent either glacial outwash plains, glacial deltas, or glacial stream terraces. The subsoil is uniformly lighter and more porous than the surface soil, and drainage is excessive. The soils of this group, which have been derived from a variety of materials, are classified in the Springdale and Garrison series.

The water-laid soils underlain by fine-textured deposits occupy portions of the extensive terrace plain in the northern part of the county and also occur in a number of the lateral valleys tributary to the main valley trough. On the whole they have a higher agricultural value than those of the preceding group, with which they are quite closely associated. They are derived from sediments laid down in slack water or in places of ponded drainage associated with the glacial period. Three series of soils are recognized, the Mission, Clayton, and Hunters.

The Springdale series includes types with light-brown surface soils, often grading to light grayish brown or light yellowish brown; yellowish-brown to light grayish brown upper subsoils; and yellowish-gray to gray lower subsoils, underlain by porous, stratified sands and gravels. (Plate I, fig. 1.) The surface soil is deficient in organic matter and rather compact, but becomes mellow upon cultivation. The subsoil is loose and open, and drainage is excessive. The coarser textured types are particularly droughty, and have a natural open parklike growth of yellow pine. Plate I, figure 2, shows a clearing on these soils.

The members of the Garrison series have dark-brown to nearly black, friable surface soils; brown, friable upper subsoils; and yellowish or grayish-brown, porous deeper subsoils, underlain by a porous sand and gravel substratum. The surface soil is fairly high in organic matter, and the moisture-holding capacity is fairly good. These soils are derived from stratified glacial outwash deposits of mixed origin, and resemble the Springdale except in color and in their prairie condition. They have a terraced surface, and tend to be excessively drained through internal means. They are well adapted to irrigation.

The Mission series is characterized by light-brown to light grayish brown surface soils, light yellowish brown subsoils, and substrata of rather compact, horizontally stratified silts and clays. These soils are forested. They are deficient in organic matter and fairly compact. No gravel or bowlders are encountered. The Mission soils occupy a terraced position, usually in lateral valleys tributary to the main valley troughs. Drainage, through internal means, is adequate.

The surface soils of the types included in the Clayton series are typically yellow to brownish yellow or yellowish brown, and have light-yellow to grayish-yellow subsoils. Near the lower part of the 3-foot section a gray color frequently appears and continues into the substratum, which consists of fine-textured, stratified material, usually more sandy than that of the Mission series and with less compact silt and clay. The soil-forming material has been derived from a variety of sources and probably deposited in glacial lakes or ponded stream valleys. The surface is nearly level, with few stream courses and those deeply intrenched in V-shaped valleys. The drainage, though slow, is adequate. These soils are forested in their native condition.

The Hunters series includes types which have dark-brown to dark grayish brown surface soils, lighter brown subsoils, and substrata of fine-textured, stratified sedimentary deposits. The material is derived from old lake-laid deposits similar to those giving rise to the Clayton series. The surface is level, but drainage is well established. The Hunters soils occupy prairie areas.

SOILS DERIVED FROM WIND-BORNE LOESSIAL DEPOSITS.

The loessial soils are most extensively and typically developed in the high, rolling plateau country in the southeastern part of the county. Isolated areas ranging from 100 acres to several square miles in extent occur in the southern portion of the basaltic plain. In the typical areas the soils are derived from a mantle of fine material 25 to 100 feet or more in depth, mainly superimposed over basaltic rock, though underlain in places by outliers or buttes of other rocks which protrude above the general level. This mantle shows practically no structural differences where observed in a number of fairly deep cuts, but in places small fragments too large to be carried by the wind are found. There is no gradation through partially decomposed rock into the unaltered rock below. The surface is rolling, and in some sections appears to be due mainly to erosion during some previous period. In other places it seems to have been modified by some agency which has developed hills having steep north slopes and more gentle southern slopes. The material is similar to previously encountered deposits believed to have slowly accumulated by the settling of dustlike material borne aloft and transported long distances by winds. Present topographic evidence indicates that much of the material was accumulated previously to the last glacial invasion. Widespread superficial redistribution and movement of the material, with probably some accessions from outside sources, is, however, being effected at the present time. Clouds of dust derived from tilled fields and from fine-textured soil materials to the west and south are of frequent occurrence and testify to the potency of wind agencies in the transportation and accumulation of soil material in this region. The material has been modified somewhat by weathering, by the accumulation of lime at some distance below the surface, and by the presence or absence of forest.

Quite extensive areas of soils in the western and central-eastern parts of the county, occurring in association with the ice-laid and residual soils derived from granitic rocks, are correlated with the loessial materials in this county. The loessial soils here have probably been modified somewhat by glacial and residual materials, and, as mapped, include areas of soil which are mainly of glacial or residual origin.

The soils derived from the loessial deposits belong to the Palouse, Helmer, and Marble series.

The soils of the Palouse series are dull dark brown to nearly black in color, and friable. The subsoils are lighter brown to yellowish brown in color, compact in structure and underlain by a tawny-yellow substratum of fine-textured material without evidence of stratification. The Palouse soils occupy rolling to undulating prairie areas and are most extensively and typically developed in the "Palouse country." Drainage is well established.

The Helmer series is characterized by light-brown to yellow soils, a gray subsurface layer, and a brown to yellowish-brown, compact and fairly heavy subsoil. The surface soil is deficient in organic matter and somewhat compact, but it becomes mellow upon cultivation. The Helmer soils occupy rolling areas, originally forested. The drainage, though mainly internal, is adequate.

The Marble series includes soils derived from sands or sandy material accumulated usually on terraces.

SOILS DERIVED FROM RECENT ALLUVIAL FLOOD-PLAIN DEPOSITS.

The recent-alluvial soils consist of sediments derived from the drainage basins of the streams along which they occur and deposited during periods of overflow. Frequently the material is from a variety of sources and has been transported for long distances. It has not been sensibly weathered in place, but in some cases it has been modified by poor drainage and in others by vegetative conditions. The areas are small and widely scattered. The soils in this group are classed in the Caldwell and Peone series.

The Caldwell series is characterized by dark-gray or drab to black surface soils and gray or drab subsoils. It occupies treeless bottoms along streams and minor basins within the rolling prairie country. The material is derived mainly from the dark-colored loessial soils. Drainage is not well established.

The Peone series comprises types which have light-gray or nearly white surface soils and gray or white compact subsoils. They occupy forested or originally forested stream bottoms where drainage is poorly developed.

SOILS DERIVED FROM RECENT SEDIMENTARY DEPOSITS OF THE GLACIAL LAKE BASINS.

The recent-sedimentary soils of the glacial lake basins occupy low-lying lake bottoms and areas of ponded drainage in stream valleys within the glaciated uplands and the terrace areas of the county. They consist of fine-textured material derived from a variety of sources and deposited in still water, later being modified to some extent by accumulations of organic matter. The surface is flat, and drainage is poor. The soils are classed with the Colville and Link series.

The Colville series is characterized by dark-gray to black soils, high in organic matter, underlain by subsoils of light-gray, heavy, plastic to tough material. Drainage is naturally poor.

The Link series includes types having light-gray surface soils, low in organic matter and of floury texture, underlain by light-gray to nearly white porous subsoils. They occupy shallow, basinlike areas in association with the Colville silt loam, dark-subsoil phase, and Scabland. The series is inadequately drained and originally supported a growth of grasses and swamp vegetation. The soils are underlain at shallow depths by basaltic bedrock.

SOILS DERIVED MAINLY FROM ACCUMULATIONS OF ORGANIC MATTER.

In situations favorable to the growth and decay of water-loving vegetation accumulations of organic matter in various stages of decomposition with the admixture of small but variable amounts of mineral material have resulted in the formation of soils ranging all the way from the brown, fibrous mass, known as Peat, to the more completely decomposed, black finely divided material known as Muck. In this survey these two soils are mapped undifferentiated as Muck and Peat, as conditions do not warrant their separation.

MISCELLANEOUS MATERIALS.

The miscellaneous group includes a number of classes of material, mainly nonarable, and generally representing a number of undifferentiated types of soil. It includes Scabland, Rough broken land, Rough stony land, and Rough mountainous land.

The following table gives the name and the actual and relative extent of each of the soils mapped in Spokane County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Palouse silt loam	188,352	16.9	Garrison coarse sandy loam	3,648	1.2
Shallow phase	1,536		Heavy phase	10,496	
Scabland	141,440	12.6	Springdale fine sandy loam	11,264	1.2
Moscow loam	18,368	8.6	Stony phase	2,624	
Shallow phase	72,896		Springdale sandy loam	13,056	1.2
Heavy-subsoil phase	5,760		Clayton sandy loam	11,840	1.1
Springdale coarse sandy loam	48,704	6.9	Palouse sandy loam	9,856	.9
Gravelly phase	10,176		Moscow very coarse sandy loam	8,064	.7
Rolling phase	9,600		Huckleberry gravelly loam	7,232	.6
Light phase	9,216		Loon fine sandy loam	6,528	.6
Rough mountainous land	62,144	5.5	Muck and Peat	6,208	.6
Cheney silt loam	56,000	5.3	Loon sandy loam	6,016	.5
Shallow phase	3,840		Colville fine sandy loam, dark-subsoil phase	5,760	.5
Rough stony land	54,720	4.9	Clayton very fine sandy loam	5,248	.5
Hesseltine stony loam	32,832	4.7	Garrison fine sandy loam	4,672	.4
Treeless phase	19,968		Hunters very fine sandy loam	4,480	.4
Garrison gravelly loam	38,400	3.5	Waits stony loam	4,224	.4
Stony phase	1,216		Caldwell silty clay loam	3,840	.3
Helmer silt loam	34,240	3.1	Hunters fine sandy loam	3,776	.3
Hesseltine loam	17,088	2.9	Marble sand	3,776	.3
Treeless phase	15,104		Mission silt loam	3,136	.3
Colville silt loam	2,432	2.3	Link silt loam	1,984	.2
Dark-subsoil phase	23,360		Waits silt loam	1,920	.2
Rough broken land	20,864	1.9	Garrison sandy loam	1,920	.2
Palouse loam	19,072	1.7	Mission fine sandy loam	1,600	.1
Palouse fine sandy loam	13,120	1.6	Marble coarse sand	1,472	.1
Slope phase	3,904		Underwood loam	1,344	.1
Shallow phase	640		Peone silt loam	1,216	.1
Clayton fine sandy loam	15,872	1.6			
Rolling phase	1,792		Total	1,123,840	
Springdale gravelly loam	17,088	1.5			
Green Bluff loam	8,448	1.5			
Slope phase	8,448				

MOSCOW VERY COARSE SANDY LOAM.

The Moscow very coarse sandy loam has a surface soil of light-brown to brown sandy loam containing a large amount of very coarse sand and very small gravel. It usually extends to a depth of about 6 inches and is underlain by a light grayish yellow or pale yellowish gray very coarse sandy loam to sandy loam. At lower depths this material grades through partially disintegrated rock into unaltered bedrock, the depth to which ranges from 2 to 5 feet. Small angular fragments of granitic rock comprise the coarse material. Large rock fragments or bowlders are not common in this type, and outcrops of the bedrock seldom occur, although in many places the soil mantle is fairly shallow. The type has a friable structure and is low in organic matter. The subsoil usually is loose and porous, and the type is not retentive of moisture. It is shallower than the Moscow loam and contains a higher percentage of coarse granitic fragments.

The very coarse sandy loam occurs in the same range of granitic hills as the Moscow loam. A number of areas are mapped near the headwaters of Deep and Deer Creeks in Ts. 27 and 28 N., R. 44 E., occupying hilly areas which are traversed by drainage ways in all directions. The slopes are short and steep and the divides narrow. There is no run-off, but rain water quickly finds its way downward, and drainage is excessive, especially where the forest cover has been removed.

Practically none of this soil is in cultivation, owing to its hilly topography, porous character, excessive drainage, and remoteness of location. The merchantable timber, mainly pine, fir, and tamarack, has recently been removed from the greater part of the type. Small trees and shrubs are fairly abundant, especially on the north slopes. Forest fires have burned over large areas. The type provides pasturage for a small number of stock. From $25 to $50 an acre is the ordinary selling price of this land, except where the timber is especially valuable.

Land of this kind is best adapted to the production of forest crops. Water for irrigation is not available, nor is the type adapted to that system of farming. By preventing fires and by a system of practical forestry timber crops of considerable value may be produced along with the growing of grasses for pasturage.

MOSCOW LOAM.

The surface soil of the Moscow loam is a light-brown to brown loam, about 7 inches deep. The subsoil is a light grayish yellow to pale-yellow or yellowish-gray loam, grading through angular, partially decomposed granite into the unaltered parent bedrock. The fine-earth mantle usually ranges from 2 to 10 feet or more in depth, but outcrops of rock occur here and there, though stones of even

medium size are uncommon. The soil carries some fine angular fragments the size of coarse sand and fine gravel. The occurrence of finely divided mica flakes is characteristic, especially in the subsoil. The type has a loose, friable structure, and is deficient in organic matter and unretentive.

In this county there is some variation in the Moscow loam. It grades on the one hand toward a silt loam and on the other toward the very coarse sandy loam of the same series. Some of the more silty areas may include minor developments of silt loam. In places where the forest is open, as bordering prairie areas of the Palouse soils, the type is slightly darker than typical.

The Moscow loam differs from the very coarse sandy loam in its greater depth to bedrock and in having a higher agricultural value. It is distinguished from its shallow phase by the smaller number of rock fragments, the less broken topography, and a higher agricultural value.

The Moscow loam is confined to the nonglaciated part of the county. It is found east of the Little Spokane River and north of the Spokane River, mainly above elevations of 2,600 feet. Some areas, however, occur in the range of hills south of the Spokane River and east of the Inland Empire Electric Railroad. A few small areas are mapped west and southwest of Marshall. There are no large continuous bodies of the type, as it covers only the better parts of the granitic hills in the eastern part of the county and is not the dominant type in any locality. One of the largest areas is mapped in the upper part of California Creek Valley, and another lies south of the Saltese Marsh.

The surface ranges from sloping to rolling and hilly, but practically all the type is cultivable. Small draws and short stream courses ramify to all parts of the type, but practically all the precipitation is absorbed by the soil material and some of it finds its way to streams through springs at lower levels. The sudden thawing of snow causes some run-off from cleared areas. There is a tendency toward excessive drainage.

About 15 per cent of the Moscow loam is used for crops. The forested areas support a growth of fir, tamarack, and pine, with an abundance of small trees and shrubs. The salable timber has been removed from a large part of the type. This soil is moderately productive. The cleared areas in individual farms are usually small, but they are being extended as the time and resources of the owners permit. Nearly all the type may be used for farm crops. Much of the type was taken up as homesteads. Some of it is so remote from centers of population that its development for farming is just beginning. The agriculture consists largely in growing subsistence crops, the surplus being sold on the local markets. Winter wheat, oats, and

tame grasses are the leading crops, followed by potatoes and other vegetables. Fair yields are obtained. Some of the type is in small orchards, but much of it lies too high for successful fruit growing. Stock raising is a minor industry. Stable manure is applied when available, but no commercial fertilizers are used.

Land of this character sells at prices ranging from $40 to $100 or more an acre, depending upon the location, improvements, and proportion of cleared land.

Like all the other forested soils of the county, this type needs more organic matter, which can be supplied by turning under green crops. It is best adapted to grains, grasses, and potatoes, and crop rotations should be planned with these as members. Fields for potatoes and sites for orchard fruits should be selected with a view to avoiding damage by frosts.

Moscow loam, shallow phase.—Areas of the Moscow loam, shallow phase, have a shallower fine-earth mantle and a more diversified and rugged topography than those of the typical Moscow loam. The phase carries a higher percentage of angular fragments, and in places rather closely approaches in texture a very coarse sandy loam. Outcrops of granite and tracts of very shallow soil are numerous. The shallow phase as mapped necessarily includes some bodies of deeper, typical Moscow loam.

The shallow phase is more extensive than any of the other soils of the series. It occurs in association with the other Moscow soils and with Rough mountainous land in the eastern part of the county. The largest areas lie to the east, northwest, west, and southwest of Newman Lake, and in the extreme northeastern corner of the county. The phase has a hilly topography and in many places is excessively drained. It supports a native growth of pine, fir, and tamarack. Almost none of the phase is in cultivation, but some of it affords pasturage. As a whole it can best be used for the production of forest crops. Portions may be used for farm crops as settlement extends to the hilly sections of the county.

Moscow loam, heavy-subsoil phase.—The surface soil of the Moscow loam, heavy-subsoil phase, is a light-brown, friable loam, of silty texture, extending to a depth of about 8 inches. The subsoil consists of a grayish-brown silt loam or silty loam underlain at about 12 inches by a brown, very compact, fine-textured loam which extends to a depth of 3 feet or more. A substratum of similar material continues for a number of feet. The material is free from rock outcrop and stone fragments of any considerable size. Under dry conditions the surface of cultivated fields has a grayish appearance. Bedrock occurs at greater depth than in the other members of the series. The soil is deficient in organic matter, but has moderately good moisture-holding capacity.

A fairly large area of this phase is mapped about 3 miles northwest of Valleyford. Others lie northeast of Freeman and north of Bell in Ts. 23 and 24, N., R. 45 E., east of Meadow Lake and northeast of Cheney, associated with the Palouse silt loam.

The surface is erosional, ranging from rolling to hilly, but is seldom steep. Drainage courses are numerous, but they were probably eroded when the climatic conditions were of a different character than at present. The greater part of the precipitation is absorbed by the soil material.

This phase does not have as wide a distribution as the typical Moscow loam, but is more important agriculturally, as approximately 85 per cent of it is farmed and practically all of it is susceptible of cultivation. Its entire area was originally quite heavily forested, but the present growth consists mainly of small pine, fir, and tamarack. The soil is regarded as moderately productive and well adapted to grain production and general farming. Its favorable location and topography and fairly good moisture-holding capacity make it a comparatively desirable soil. Wheat is the leading crop, followed by oats, tame grasses for hay, and potatoes. Moderate yields of wheat are obtained, but the yields of oats are uncertain.

The selling value of this land ranges from $75 to $100 an acre.

One of the greatest needs of this soil, like all the types devoted largely to grain farming, is the adoption of some system of crop rotation, as only one crop is obtained in two years when summer fallowing is practiced. Green crops should be turned under to increase the organic content and improve the moisture-holding power of the soil.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the typical Moscow loam:

Mechanical analyses of Moscow loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551303	Soil	4.2	4.6	1.4	5.8	17.6	52.6	13.7
551304	Subsoil	8.8	10.4	3.1	10.1	15.2	42.4	9.7

HUCKLEBERRY GRAVELLY LOAM.

The Huckleberry gravelly loam consists of about 6 inches of brown or somewhat reddish brown gravelly loam, in places of rather silty texture, underlain by pale-yellow to yellowish-brown gravelly loam, usually extending to a depth of 3 feet or more. The gravel content of the type is unusually high. The gravel occurs on the surface and throughout the soil section, and in places seems to comprise the bulk of the material. It consists of angular to subangular rock fragments,

of medium to small size, mainly quartzite and partly metamorphosed sandstone. In places larger angular fragments occur on the surface and embedded in the material. Rock outcrops are seldom encountered. About half the area of this type is forested. The surface soil in the treeless areas is slightly darker in color, has a lower gravel content, and merges gradually with the lower-lying Palouse silt loam.

The largest area of Huckleberry gravelly loam is mapped on Tekoa Mountain, in the extreme southeastern part of the county. Smaller areas lie to the north and northwest. Two small areas cap the tops of the hills west of Medical Lake, and another occurs on Browns Butte.

The type occupies the highest elevations in the locality where it occurs. It generally covers the tops of hills whose lower slopes are occupied by the Palouse silt loam. The surface ranges from hilly to rough, and with the porous structure causes excessive drainage.

None of this type is under cultivation. The treeless portion provides pasturage for stock, but the forested areas do not afford much grazing. The largest wooded area comprises the top and the north and east slopes of Tekoa Mountain. Much of the west slope is treeless, as are also the smaller areas of the type. The timber is mainly fir, with some tamarack on the east slopes.

This is a relatively unimportant soil agriculturally. Some of it is too hilly for farming, but a considerable acreage could be farmed in connection with the adjacent types were it not for the excessive drainage.

The following table gives the results of a mechanical analysis of a sample of the soil of the Huckleberry gravelly loam:

Mechanical analysis of Huckleberry gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551310.....	Soil.....	10.0	7.0	1.7	6.0	14.1	45.3	15.8

UNDERWOOD LOAM.

The Underwood loam where typically encountered elsewhere has a brown to somewhat reddish-brown soil and subsoil containing small pellets or rounded aggregates of brown or reddish-brown, cemented material. In the present survey, however, the soil is not typical of the Underwood loam, but represents a shallow variation, of pronounced reddish-brown to deep-red or dull-red color, and in which the usual shotlike pellets are absent. The topography is also flatter and smoother and the soil is less heavily forested than in sections where it is typically developed.

In Spokane County the Underwood loam has a soil of pronounced reddish-brown or dull-red loam, 6 to 10 inches in depth, underlain either by bedrock or by a thin intervening zone of weathered soil material only slightly lighter in color. Both soil and subsoil carry a few small, angular fragments of basalt, which is always the underlying parent rock. Small mounds occur throughout the type, and on these the soil mantle has a depth of about 3 feet. Outcrops of the horizontal basaltic bedrock are fairly common.

This type occurs in association with the Hesseltine stony loam and loam and Scabland, in the southwestern one-fourth of the county. The largest area lies west of Tyler. All the remaining areas are small.

In general the surface is level to slightly undulating. The soil readily absorbs the little precipitation which falls, and not enough moisture is retained for the successful production of crops.

All the type supports a growth of scattered yellow and jack pine. There is little or no underbrush. Bunch grass, a characteristic plant, affords pasturage. The type is of small extent and relatively unimportant. It could, however, be used successfully for shallow-rooted crops with irrigation. Its sale value is similar to that of the surrounding types.

LOON SANDY LOAM.

The soil of the Loon sandy loam is a light brownish yellow to light yellowish brown, rather coarse, sandy loam, extending to an average depth of about 6 inches. The subsoil is a pale-yellow or grayish-yellow, stony, coarse sandy loam, underlain at 18 to 20 inches by a stony, somewhat finer sandy loam which extends to a depth of 3 feet or more. Angular granitic fragments ranging in size from coarse sand to fine gravel are fairly abundant, and gravel, cobbles, and bowlders of subangular to rounded shape are present in varying quantities. The type is underlain by granitic bedrock, and areas of shallow soil and of rounded granite outcrops are fairly common. The soil is porous and deficient in organic matter.

The Loon sandy loam carries more stones and is shallower than the fine sandy loam of the series, and grades into adjacent areas of Rough stony land. It probably includes some areas of soil partly residual, derived from underlying granitic bedrock or included bowlders.

The type is confined to the glaciated granitic section in the northwestern part of the county. It is most extensive in T. 27 N., R. 42 E. Several areas lie near the Stevens County line in Ts. 28 and 29 N., R. 42 E. Two areas are mapped northeast of Eloika Lake, and one northeast of Elk on the Pend Oreille County line.

The surface ranges from rolling to hilly. The slopes and ridge crests are rounded, without being gullied, and the country does not present the irregular appearance of the residual areas. There are few drainage courses, since the soil absorbs all the normal precipitation.

This is a rather inextensive and comparatively unimportant type. Less than 1 per cent of it is in cultivation. The forest growth consists of pine, fir, and tamarack, with considerable underbrush. The proportion of merchantable timber is now rather small. A somewhat remote location, hilly topography, and the rather shallow soil over part of the type are responsible for its very slow development for farming. Agriculture is confined to small clearings on scattered homesteads. Hay, grain, and potatoes are grown for home use, and give moderate yields. This land seldom changes hands, but its sale value ranges from $25 to upward of $60 an acre.

Methods of farming should be adopted which will enable this type to hold more moisture, such as deeper plowing, the turning under of green vegetation, and the use of winter cover crops. The soil is best adapted to early-maturing crops, and winter wheat does better than the spring varieties for this reason.

The following table gives the results of a mechanical analysis of a sample of the soil of the Loon sandy loam:

Mechanical analysis of Loon sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551318.....	Soil.....	11.7	18.3	9.0	26.5	8.8	20.0	5.6

LOON FINE SANDY LOAM.

The Loon fine sandy loam consists of about 6 inches of brownish-yellow or yellowish-brown fine sandy loam underlain by yellow, light fine sandy loam which extends to a depth of 3 feet or more. The surface soil is loose and friable, and carries very little coarse sandy material. The subsoil contains gravel, cobbles, and bowlders, mainly granitic, but in less quantities than in the Loon sandy loam. A few large bowlders are present on the surface, and granite outcrops occur in a few places, but the fine earth mantle is usually several feet in thickness. The type is deficient in organic matter.

A few areas of loam texture are included with this type. These consist of light-brown to brownish-yellow loam extending to a depth of about 6 inches and underlain by a yellow, light loam to sandy loam extending to 3 feet or more. Such areas resemble the Waits soils almost as closely as they do the Loon.

The greater part of the Loon fine sandy loam occurs in T. 27 N., R. 42 E. Other areas are found along or near the Stevens County line in Ts. 28 and 29 N., R. 42 E. The type is closely associated with the Loon sandy loam.

A sloping to rolling or moderately hilly surface characterizes this type, which in places is too steep for cultivation. The drainage is

well established. Only small streams and draws traverse the type. These receive water mainly from seepage and springs, as the run-off is negligible.

The Loon fine sandy loam is of comparatively small extent, and less than 25 per cent of it is used for crops. The greater part of the type has been logged off, but its development for farming has not kept pace with the removal of the timber. The native forest consists of pine, fir, and tamarack, with abundant underbrush, the latter being especially dense on the areas that have been logged off. Settlement is rather scattered, and the clearings are usually small. Subsistence crops such as hay, grain, and potatoes are grown most extensively. A little stock is kept. Most of the wheat grown is winter wheat. Fruit is produced for home use. Late-maturing crops are sometimes damaged by frosts.

At present there is little demand for land in the more or less hilly sections of the county where this type is found. The sale value depends upon the state of improvement, the location, and the character of the forest growth. It ranges from $25 to $75 an acre.

This type is best adapted to the production of general farm crops, with dairying as a side line after a sufficient acreage has been cleared to provide forage for stock. Late crops are sometimes injured by droughts, and farming methods should be adopted which will enable the type to hold more moisture within reach of growing crops. Turning under winter cover crops or any green crop in the spring, will make the soil more retentive of moisture. Water for irrigation is not available, and very little of the type is suited to irrigation farming.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the Loon fine sandy loam:

Mechanical analyses of Loon fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551320	Soil	1.3	5.3	4.4	26.8	20.6	33.4	8.1
551321	Subsoil	2.7	9.6	6.0	32.0	19.7	23.8	6.1

WAITS STONY LOAM.

To a depth of about 6 inches the Waits stony loam is a brown to light-brown silty loam which carries large quantities of bowlders on the surface and through the soil. The subsoil is a pale-yellow to yellowish-brown loam, which is also very stony and which extends to a depth of 3 feet or more. The underlying material, consisting of either stratified deposits or bedrock, is encountered at depths ranging from 3 to 10 feet or more. The only essential variation in

this soil is in the proportion of stone. The type has a porous structure and is deficient in organic matter.

This soil is found in the Little Spokane River and Bear Creek Valleys as far south as Chattaroy. The largest area lies south of Eloika Lake. Four small areas are mapped about 2 miles southeast of Mead.

The Waits stony loam does not have a great diversity of topography, though its surface is in some places quite irregular. Much of the type has a low morainic topography, while other areas are almost as level as a terrace. It closely resembles valley drift and differs in this respect from the Waits silt loam, which occupies high hilly areas. Practically all the drainage is downward through the soil, and the internal movement of water is so rapid that drainage is excessive.

There are less than 7 square miles of this soil in Spokane County and none of it is in crops. Yellow pine, with here and there some brush, comprises the forest growth in the southern areas of the type. West of the south end of Eloika Lake there is a dense stand of fir, tamarack, and brush. The type has no present and little future agricultural importance, as the time and labor involved in clearing the land of stones is prohibitive, especially where it is inclined to be droughty. It is best adapted to the production of forest and pasture crops. Its value is based largely on the timber, as there is no demand for this land for farming purposes.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the Waits stony loam:

Mechanical analyses of Waits stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551314	Soil	8.4	8.8	2.0	8.0	18.2	43.4	11.3
551315	Subsoil	16.3	18.2	3.6	10.6	13.4	33.1	4.5

WAITS SILT LOAM.

The Waits silt loam typically consists of about 6 inches of light-brown to brown silty loam or silt loam, underlain by yellowish-brown silt loam which extends to a depth of 3 feet or more. There are few bowlders on the surface and the soil typically does not contain a large amount of rock fragments, but the subsoil usually contains rather large quantities of stones, mainly quartzite. In places, however, it also is almost stone free. Except in the few small areas, indicated on the map by rock-outcrop symbols, rock outcrops are uncommon. The underlying rock, mainly quartzite, lies from a few to several feet below the surface. The soil is moderately friable and open, and is deficient in organic matter.

This type occurs most extensively along the northern border of the county from the northwest corner to Eloika Lake, adjoining areas mapped in Stevens County to the north. Another area lies about a mile east of Camden, on the county line. The surface is rolling to hilly, the type in this county occupying the lowest slopes of a high range of hills which lie mainly in Stevens and Pend Oreille Counties to the north. No well-defined drainage channels cross the type, all the precipitation readily finding its way downward through the soil.

The Waits silt loam is an inextensive soil in this county, though covering large areas in Stevens County to the north. Nearly all of the glacial-till soils in this county are derived largely from granitic or basaltic rocks, and material from metamorphosed sedimentary rocks, giving the Waits series, is of small extent.

Only a few acres of this soil are cleared and cropped, although a fairly large percentage of it is cultivable. The availability of less hilly land nearer to market and transportation facilities has retarded its development. The native forest growth consists of yellow pine and tamarack with considerable underbrush, and native grasses grow where the forest is not too thick.

Hay, grain, potatoes, and fruits are grown on this soil. It is regarded as fairly productive and quite well adapted to the general farm crops of the region. Late-maturing crops are sometimes injured by frosts. The selling value of this land ranges from $25 to upward of $50 an acre. The type can be improved by the same methods that are suggested for the soils of the Loon series.

The results of mechanical analyses of samples of the soil and subsoil of the Waits silt loam are given in the following table:

Mechanical analyses of Waits silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551316	Soil	3.4	6.8	2.9	14.1	19.3	44.0	9.4
551317	Subsoil	7.3	14.5	6.1	17.6	20.2	24.4	9.4

HESSELTINE STONY LOAM.

The surface soil of the Hesseltine stony loam is a brown loam, about 6 inches in depth, containing rather large quantities of rock fragments of all sizes on the surface and embedded in the soil. The subsoil is a light-brown or yellowish-brown to brown very stony loam, usually extending to bedrock, which as a rule exceeds 3 feet in depth. The depth to bedrock is, however, quite irregular, ranging from a few inches to 6 feet or more within short distances, with outcropping ledges of rather frequent occurrence. The stone con-

sists of angular to subangular and rounded fragments, principally basalt with a small percentage of granite. They range all the way from gravel to bowlders of medium size. When moist the soil is friable, but it becomes hard and compact when dry. As a whole the type is porous and low in organic matter.

Variations in this type are largely a matter of variation in stone content. In some places the subsoil is made up almost entirely of unassorted rock fragments. When moist, parts of the type have a decidedly reddish brown color, especially the shallower areas and those under which the basaltic bedrock is somewhat weathered and has a slightly reddish color and a vesicular structure. In a few places the surface soil has a grayish to very light brown color. This is true of some areas associated with the Cheney silt loam in the northwestern part of the county. The type differs from the stony soils of the Cheney series in that the color of the latter is dark as a result of prairie conditions, whereas the Hesseltine typically is forested.

The Hesseltine stony loam is mostly confined to the western half of the county, where it occurs in association with the Cheney soils and the other members of the Hesseltine series. It is probably most closely associated with Scabland. The type is most extensive in T. 23 N., R. 43 E., and T. 24 N., R. 42 E. An area covering a little more than 2 square miles lies north and west of Valleyford, in T. 24 N., R. 44 E.

All the areas in the western part of the county occupy part of the extensive, fairly level plain which extends from the Spokane River on the north to the Whitman County line on the south and from Spokane on the east to the Lincoln County line on the west. This plain varies in elevation from 2,200 to 2,400 feet. In detail the surface is slightly uneven or bumpy and typical of ice-laid deposits. There are practically no drainage ways across the type, and very few in that portion of the county in which the type is found, all the drainage being internal. The precipitation that falls upon this soil is slight and always gentle, the soil being wettest when the snow is melting. At times it drains rather slowly on account of the close, massive structure of the underlying rock.

This is a moderately extensive and fairly well distributed soil. Little or none of it is under cultivation, and it supports its original growth or second growth of yellow pine or is in a logged-off condition. Native grasses grow quite abundantly, as very little of the type is thickly forested. These afford considerable pasturage during a part of the year for dairy stock and cattle on farms on adjacent soils.

This land does not at present find a ready sale. It is owned or leased in quite large tracts with associated soils, mainly as parts of large dairy and stock farms. Its sale value depends upon its

location and the character of the adjoining soils and ranges from $25 to upward of $75 an acre.

In most places this soil is not so stony that the removal of the stones is impracticable, as they are mostly of small to medium size. The cost of clearing the land of forest also is not prohibitive, as the growth is rather scattering. The lack of development is due to the low productive capacity of the type under dry-farming methods and its greater value for pasturage. It is adapted to all the common crops of the region under irrigation, and fair yields may be expected. Water is available only by pumping, and as no attempts have been made, it is not known whether water may be obtained in sufficient quantities to make irrigation farming successful. The best use of the type is probably for producing pasture and forest crops.

Hesseltine stony loam, treeless phase.—To a depth of about 6 inches the surface soil of the Hesseltine stony loam, treeless phase, is a brown to moderately dark brown or reddish-brown loam, with fairly large quantities of stone scattered over the surface and embedded in the soil. The subsoil ranges from a brown or reddish-brown stony loam to a mass of rock fragments with little fine interstitial material. It extends usually to a depth of 3 feet or more. The fine earth mantle is comparatively shallow, and basaltic bedrock is usually encountered at depths varying from 2 to 6 feet. Outcrops of basalt are fairly abundant.

This soil differs from the typical Hesseltine stony loam in being slightly darker in places. The typical soil is uniformly brown. The treeless phase of the stony loam is more extensive and more widely distributed than the same phase of the Hesseltine loam.

Areas of the Hesseltine stony loam, treeless phase, occur in the western half of the county in the plainlike country, which extends from the Spokane River to the Whitman County line. It occurs in association with the Cheney silt loam, the other soils of the Hesseltine series, and Scabland.

The surface is nearly level except for the swells which are characteristic of all the ice-laid soils in the western part of the county. The type lies 2,300 to 2,400 feet above sea level. No stream ways have been developed and all the drainage is internal. The porous structure allows rather free movement of water, so that it sinks beyond reach of the common crops.

At least 95 per cent of this phase supports a cover of bunch grass, with here and there some sagebrush. Practically none of the land is cultivated, but it is used for pasture.

This land does not have a ready sale. Some of it has been divided into small tracts, along with the associated soils. The present selling value depends upon the character of the surrounding land.

This soil is not considered too stony for farming, although considerable time and effort will be necessary for its preparation, and it is probable that its productive capacity under dry-farming methods will not warrant the cost. Intensive farming under irrigation would doubtless prove profitable for crops which do not require too long a season, since the phase lies at too high an elevation for the successful production of some crops. Water for irrigation is not available, except by pumping from deep wells, and the results would not at present justify the expense.

HESSELTINE LOAM.

The surface soil of the Hesseltine loam is a brown to reddish-brown loam usually extending to a depth of about 6 inches. The subsoil is a brown loam, stony in character and rather open in structure, which usually extends to a depth of 3 feet or more. It is underlain by basaltic bedrock at a depth of 3 to 6 feet or more. Subangular to rounded glacial stones and bowlders of medium size, mainly of basalt but occasionally of granite or quartzite, occur on the surface, and sparingly in the surface soil. The rock content of the subsoil is much larger, and in places nearly all the subsoil is composed of stones. These are usually smaller than in the soil. Low, rounded outcrops of basaltic bedrock occur in a few places. Here and there small areas of shallow soil closely resembling Scabland are included with the type. Under moist conditions the soil has a friable structure, but when dry it bakes and becomes very hard. It is deficient in organic matter.

Variations in this type are mainly in the stone content and the depth of the soil material. Areas of the Hesseltine stony loam, where such material is of small extent, are included on the map, as the boundaries between the two types are more or less arbitrary. The loam type, on the other hand, grades toward Scabland, and some small areas closely approaching that soil are included. In a few places small, poorly drained areas of Colville silt loam, dark-subsoil phase, are included. Some areas are decidedly reddish brown in color when moist.

The Hesseltine loam is mainly confined to the western half of the county. A few small areas occur in the eastern part, several being mapped west of Mica and north and southwest of Valleyford. Another area is found south of Deer Park. The type is widely distributed over the western half of the county, but the areas are relatively small and it does not predominate in any locality.

The surface is level to very gently sloping. Small, slightly depressed or basinlike areas occur here and there, as well as small, rounded knolls or outcrops of the underlying rock. The type has adequate drainage, though it drains slowly after heavy precipitation on account of its level character and the nearness of the bedrock to the surface.

About 35 per cent of the type is in cultivation, the remainder comprising abandoned fields, cut-over areas, and forest lands, occupied by a scattered growth of yellow pine with some pine reproduction in places. Native grasses are fairly abundant. Grain and potatoes are the only crops of importance. There are a few small orchards. The type affords pasturage for a considerable number of stock during certain seasons of the year, and the agriculture usually is closely associated with that on the Colville silt loam, dark-subsoil phase, on which dairy farming is fairly well developed. Yields are low or only moderate, as the type is readily affected by drought, and late crops are seldom successful. Hay is not grown to any considerable extent on account of the better adaptation of the associated Colville soil to this crop.

Land of this type has a greater value where included in farms with the Colville silt loam, dark-subsoil phase. Few sales are reported. The selling value depends upon the location, the associated types, and the improvements, and varies from $25 to $75 or more an acre.

The Hesseltine loam needs more organic matter, which may be supplied by turning under cover crops and green-manure crops. Legumes, on account of their nitrogen-gathering properties, should be used for this purpose as far as possible. Deeper plowing would also be beneficial. A considerable proportion of the type would be adapted to irrigation were water available. The only possible source seems to be pumping, and it is probable that water thus obtained would be too expensive for general farm crops.

Hesseltine loam, treeless phase.—The Hesseltine loam, treeless phase, consists of a brown to reddish-brown loam, underlain at about 6 inches by a light-brown loam which extends to a depth of 3 feet or more. As a rule the bedrock of basalt is 6 feet or more below the surface. There are a few stones on the surface and within the 3-foot section. Patches of shallow soil and of rock outcrop are found here and there. The surface of plowed fields presents a spotted brown and dark-brown appearance, sometimes one color predominating and again the other. The brown color is typical of the slight hummocks and the dark brown of the intervening areas.

This phase closely resembles the typical Hesseltine loam in color, texture, and general appearance. For some reason, it has not been forested, at least for a long time, but though treeless the surface soil has not assumed the typical dark-brown color of the strictly prairie types. In place of a forest cover, at least a large part of the phase has had a native growth of sagebrush, and the native grasses have not been sufficiently luxuriant to impart enough organic matter to give a dark color. The surface soil differs from that of the Cheney silt loam in its lighter brown color.

This phase of the Hesseltine loam is confined almost entirely to the Sunset Prairie west of Spokane. One of the largest areas lies in the vicinity of Hayford and Jamieson Park. Others are found northwest of Walters, on the Washington Water Power Co. electric railway, in T. 24 N., R. 41 E.; southwest of Deep Creek; in T. 24 N., R. 40 E.; and about 1½ miles east of the Crescent School in T. 26 N., R. 40 E. The Cheney silt loam, Scabland, and the Hesseltine stony loam, treeless phase, are the most commonly associated soils.

The extensive plainlike area over which this phase is distributed has an elevation of about 2,300 to 2,400 feet. The areas are generally level except for numerous swells, which are characteristic of ice-laid material. No drainage courses traverse this soil, and all the drainage takes place downward through the subsoil, which permits the ready movement of water. In places where the bedrock is close to the surface, the drainage is slow after the sudden thawing of snow.

The Hesseltine loam, treeless phase, is not an extensive soil, but approximately 80 per cent of it is either now in cultivation or has been within the last few years. The abandoned portion supports a cover of scattered bunch grass and weeds. The unbroken area has a cover of bunch grass, with some sagebrush. At one time there was evidently a marked farming development on this soil, as land subdivisions, small orchard tracts, and vacant houses indicate. The acreage now in cultivation, though not as large as formerly, is larger than in the last few years, as some virgin fields are now being put in cultivation to wheat. Conditions seem to indicate that farming after the first few years was not successful without irrigation. Attempts have been made to irrigate certain portions of the phase, but during the present season (1917) practically none of it was farmed under irrigation. At the time of the survey only recently cleared fields and the most favorable portions of the older fields were being farmed. Wheat is the leading crop, the other cereals being seldom grown. Wheat gives only medium yields, and in some seasons much of the crop is cut and cured for hay. Orchard tracts occupy the greater part of the remainder of the cultivated area. Many of these orchards have been very poorly cared for, and some of them are practically abandoned. Others seem to be doing fairly well, though only a few are in bearing. The uncultivated portion of the type affords some pasturage.

The selling value of this land is difficult to determine. Much of it has been subdivided into small tracts, and some of them sold for prices much greater than the present conditions warrant. A considerable acreage is situated comparatively near the Washington Water Power interurban line to Cheney and Medical Lake, and also within 10 miles of the city of Spokane, and this is responsible in

part for the high valuation. Based on the present returns from farming, the selling value of this land should be low. There is not much exchange of land of this kind at the present time. It is held at prices ranging from $25 to $100 or more an acre.

The incorporation of organic matter through the turning under of green-manuring crops, preferably legumes, would aid this soil to hold moisture for late-maturing crops. It is better adapted to intensive than to general farming, but for the success of the former irrigation is essential and an abundant supply of water is necessary, as the soil material is porous. It seems doubtful whether a large enough supply can be obtained by pumping from deep wells at a cost that will enable the profitable production of crops, and the necessary amount of water is not available by pumping from other sources.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the Hesseltine loam and its treeless phase:

Mechanical analyses of Hesseltine loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Typical soil:		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551324	Soil	3.4	5.8	1.7	9.4	20.4	46.5	13.0
551325	Subsoil	4.2	6.0	1.4	9.0	19.4	46.3	13.9
Treeless phase:								
551330	Soil	6.6	11.9	5.0	13.4	17.1	36.3	9.6
551331	Subsoil	6.0	12.9	5.0	13.4	15.0	37.3	10.1

CHENEY SILT LOAM.

The surface soil of the Cheney silt loam is a dark-brown silt loam, 6 to 8 inches deep. The subsoil is a yellowish-brown or yellow loam or silt loam which extends usually to a depth of 4 to 6 feet or more, or to the underlying bedrock. There may be a few rock fragments on the surface and in the surface soil. The subsoil usually carries some stone, but it varies greatly in stone content and may be either stone-free or too stony to permit the use of the soil auger. The rock fragments are mainly basaltic, but there are occasional granite bowlders. Patches of shallow soil, with outcrops of the underlying basaltic rock occurring in places, are typical. The more extensive of these are separated and shown on the map as a shallow phase. The soil of the Cheney silt loam is friable and fairly high in organic matter.

Variations in this type are mainly in color and in depth of the soil material. The range in color is from medium dark brown to very dark brown, dark gray or black. The type occupies treeless areas and the color becomes lighter near the forested soils. In places

scattered trees have encroached on the prairie, so that the boundary of the type is sometimes 200 feet or more inside of the forest line, some of the small included forested areas thus having a lighter color than typical. The areas near the western limits of the county do not have as dark a color as those farther east.

The Cheney silt loam occurs on the prairie portions of the basaltic plateau or plain in the western part of the county. Several well-defined areas occupy local prairies, among which are Four Mound Prairie, in T. 27 N., Rs. 40 and 41 E.; Indian Prairie, in T. 26 N., Rs. 40 and 41 E.; Sunset or White Bluff Prairie, in Ts. 24 and 25 N., R. 41 E.; Malloy and Tucker Prairies in T. 24 N., R. 40 E.; and Paradise Prairie, in T. 23 N., R. 43 E. Other areas occur in the vicinity of Cheney, northwest of Spangle, and elsewhere. The soil types generally associated are those of the Hesseltine series, with their treeless phases, and Scabland.

The type occupies portions of a generally level plain, from 2,200 to 2,400 feet in elevation. The areas are either level or very gently undulating as a result of the slight rises or swells typical of the ice-laid soils overlying basaltic rock in the western part of the county. The low elevations are due in large measure to the uneven surface of the underlying rock. Like all the related types, this soil has practically no drainage channels. The precipitation is light and gentle, and the soil absorbs all of the rainfall. In long periods of drought, late-maturing crops suffer from lack of moisture.

This is the most extensive and most widely distributed of the glacial soils. Approximately 80 per cent of it is used for annual crops. The remainder comprises abandoned fields and areas of the original prairie, with its bunch-grass cover. Though some of the type lies at considerable distance from market, its development has not been much retarded. Other areas are not far distant from Spokane and are easily accessible to the interurban lines connecting Cheney and Medical Lake with Spokane. Early settlement on this soil was favored by its prairie character, the type affording good grazing for live stock and requiring little labor to be put in shape for crops. It is regarded as a desirable soil both for general and special crops.

General farming, with wheat as the chief crop, is the leading system of agriculture. Orcharding is an industry of some importance on part of Sunset Prairie. In some places the type forms part of dairy farms and is used in the production of forage crops. Potatoes are grown on a small acreage, and trucking is a minor industry. Yields are quite seriously affected when the rainfall is less than normal, as the fine-earth mantle is rather shallow and the type somewhat porous. Wheat yields 10 to 35 bushels per acre.

There is little or no rotation of crops on this type, and wheat is usually grown for a number of years in succession, except for the

seasons in fallow. Spring wheat is increasing in popularity. A large part of the wheat land is plowed in the fall. The methods of growing wheat are about the same as on the Palouse and Helmer silt loams, the soils most extensively used for this crop.

The location, the improvements, the nature of the associated soils, and the productive capacity all influence the selling price of this type, which ranges from $50 to $100 or more an acre.

The dark color of this soil indicates that it has a fairly adequate supply of organic matter, and it holds more moisture than similar soils which have been in forest, but nevertheless methods should be adopted which will aid in conserving moisture, such as deeper and better plowing and frequent cultivation. The type would be well adapted to intensively farmed crops, especially under irrigation, but this system of farming has not been developed to any extent on account of the lack of water supply. The Spokane River flows at too low a level, and pumping for irrigation has not been practiced to a sufficient extent to determine its cost.

Cheney silt loam, shallow phase.—Occasional outcrops and patches of shallow soil are typical of the Cheney silt loam, but such areas when of sufficient size are mapped as a shallow phase, in which are grouped areas of dark-colored soil which represent gradations toward Scabland. There is such an intricate association of areas of rock outcrop, shallow soil, and soil of average depth that further separation is impossible. The range in texture of the surface soil is from a very fine sandy loam to a silt loam, but the agricultural difference is slight.

A considerable part of this land is in cultivation. It is used for the same crops and in the same way as the areas of deeper typical soil.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical Cheney silt loam:

Mechanical analyses of Cheney silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551326	Soil	3.6	5.8	1.8	9.4	19.6	54.5	5.3
551327	Subsoil	2.5	6.0	2.0	10.4	20.8	52.9	5.4

GREEN BLUFF LOAM.

The Green Bluff loam in its typical development consists of a yellowish-brown or light-brown loam underlain at about 8 inches by a yellow or brownish-yellow very fine sandy loam to silt loam. This material continues to a depth of 6 feet or more and is underlain at 6 to 15 feet or more by stratified old lake-laid deposits overlying

basalt. Outcrops of bedrock do not occur in the typical Green Bluff loam, and, aside from a few bowlders, the type is fairly free from rock fragments. Both soil and subsoil have a friable structure. The surface soil is low in organic matter, and the immediate surface layer when dry shows a grayish color.

This type differs from the forested Helmer soils, of similar color, not only in the much less compact structure of its subsoil and in the absence of the gray subsurface layer of the Helmer, but also in origin. The Clayton soils also resemble it but differ in origin as well as in position. The only soils of glacial ice-laid origin that at all resemble this type are those of the Waits series, and this type differs from the Waits silt loam in its less silty texture and in having a much smoother topography, a lower stone content, and a higher agricultural value. Also, it is underlain by stratified lake beds and basalt in contrast to the quartzite bedrock of the Waits.

The Green Bluff loam is found almost wholly in the north-central part of the county, in Ts. 26, 27, and 28 N., Rs. 43 and 44 E. One area lies about 3 miles east of Chester, and another southwest of Valleyford. The type occurs at the same level and has the same relative position as the Palouse fine sandy loam.

This soil occupies plateaulike areas about 2,300 to 2,400 feet in elevation and lying about 400 feet above the stream and lake deposits to the west. On the east it is bordered by the high, rolling to hilly granitic hills. Steep slopes and perpendicular walls of basalt mark the descent to the lower lying soils. The areas are level to gently undulating (Pl. II, fig. 1), separated by lateral valleys which are tributary to the main north and south valley trough. The type is well drained at all seasons, although there is practically no run-off at any time.

All of this soil was originally forested, but approximately 75 per cent of it is now in cultivation. The remainder has a fairly thick stand of fir and tamarack, with an undergrowth of brush, and comprises the uncleared portions of farms. Favorable topography, good drainage, and natural productiveness are responsible for the rather extensive development of this type. It is accessible by roads which have either long or steep grades, and some of it lies at quite a distance from transportation and marketing facilities.

Wheat is grown on the largest acreage, followed, in the order named, by fruit, tame grasses, strawberries, and potatoes. Strawberries, though produced on a small acreage, are an important crop. This is the only soil in the county on which strawberry growing is a specialized industry. On other types they are grown only between the rows of fruit trees. The orchard fruits consist of apples and cherries, mainly the former. Most of the orchards are small, but the trees are 5 to 15 years old and are making a vigorous growth. The greatest

acreage of orchard and small fruits is in T. 27 N., Rs. 43 and 44 E., in the Green Bluff district. Intensive farming is also carried on in the Foothill district. The Spokane County strawberries grown on this type have the advantage of coming on the market late, usually during the first half of July, and they command a fairly high price. They are marketed largely in Spokane. Good yields of berries of fine quality are obtained. In favorable years the yields of orchard fruits are satisfactory, although the type lies at too great an elevation for the long-season varieties. Winter wheat is grown and yields from 10 to 30 bushels per acre.

This soil, though deficient in organic matter, holds moisture well if given frequent shallow cultivation. Borings indicate a very marked difference in moisture content between fields of wheat and those of intensively farmed crops.

There is a wide variation in land values on this soil from place to place. Small farms in orchards and small fruit are held at $300 to $500 an acre, the lower prices prevailing when the acreage in orchard does not comprise the whole farm. Farms on which grain is the chief crop are valued at $75 to $100 or frequently more an acre. Farms largely in forest and containing a considerable percentage of rough land are held at $50 to $75 an acre. The cost of clearing this land is fairly high. All the trees are cut, the slashings burned, and all the stumps removed before a field is put in cultivation.

As this type has been in cultivation for only a few years, its normally low organic content has not been completely exhausted. No attention has been given to maintaining or restoring this material, so essential to the holding of sufficient moisture. Green crops should be turned under at intervals, and a rotation suited to the needs of the soil and to the system of farming should be adopted.

Green Bluff loam, slope phase.—The slope phase is similar to the typical Green Bluff loam except in position, topography, and stone content. It consists of a yellowish-brown silt loam underlain by a yellow very fine sandy loam or silt loam to a depth of 3 feet or more. A few glacial bowlders occur on the surface and within the soil and subsoil. The soil mantle overlies an uneven surface of basaltic rock, and outcrops occur in places, as well as areas of shallow soil, in which angular basaltic fragments are found on the surface and within the 3-foot section.

This phase occurs in the same portions of the county as the typical soil. It occupies the slopes between the more or less flat, plateaulike areas of typical Green Bluff loam and the lower lying terrace soils. Frequently a belt of Rough stony land or Rough broken land, or of both, lies between the typical Green Bluff loam and this phase. The surface is rolling to moderately hilly, and drainage is everywhere adequate.

Less than 50 per cent of the area of this phase is cleared and farmed. The remainder supports a thick stand of fir, tamarack, and pine, with considerable underbrush. The phase is slightly nearer markets and is more accessible than the typical Green Bluff loam, but its development for farming has not been as rapid. Very little of it is intensively farmed to orchard and small fruits. Grain, tame grasses, and potatoes are the leading crops, and all give fairly good yields. Stock raising is carried on as a side line on some farms. The clearings on individual farms are for the most part small and are being extended as the sale of timber and wood and the other farm operations permit.

The phase is farmed in conjunction with soils of the Springdale and Mission series, and its selling value is frequently dependent upon that of the associated types. The range is probably from $50 to $100 an acre.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the typical Green Bluff loam:

Mechanical analyses of Green Bluff loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551334	Soil	1.4	2.8	1.0	9.7	32.1	43.0	10.0
551335	Subsoil	.8	1.7	.8	13.6	42.0	32.8	8.0

SPRINGDALE GRAVELLY LOAM.

The soil of the Springdale gravelly loam is a light grayish brown gravelly loam extending to a depth of 6 to 8 inches. The subsoil consists of a pale-yellow or grayish-yellow gravelly loam underlain at about 15 inches by gray sandy gravel which extends to a depth of 3 feet or more. The substratum consists of a bed of gravel and cobbles with interstitial sands. The fine material in the soil and upper subsoil is rather high in silt, and in its natural state the soil is fairly compact, but the lower subsoil and substratum are very porous. The gravel consists of well-rounded, medium-sized fragments of granite, schist, quartzite, and slate, and is quite equally distributed throughout the type. In places a few cobbles and small bowlders are scattered over the surface and embedded in the soil mass.

This is a fairly uniform type. In places it includes small alluvial fans of finer texture, and in slight depressions very fine sandy and silty material without gravel. In a few instances the texture grades toward a gravelly sandy loam.

The type occurs in the valleys of the Spokane and Little Spokane Rivers. In the former the greatest development is between the city of Spokane and the junction of the two rivers. In the latter valley it is found quite extensively between Milan and Chattaroy. Rough broken land is the most commonly associated soil.

The type occupies a distinct terrace, usually the lowest, and intermediate between the Springdale coarse sandy loam and the stream channel. It lies 75 to 150 feet or more above the present stream channels, and from 1,800 to 2,000 feet above sea level. It has a level surface, with steep terrace fronts mapped as Rough broken land facing the rivers and a similar slope rising to the higher terrace. Drainage is internal and is practically everywhere excessive.

The gravelly loam is one of the most extensive types of the Springdale series. It is of low agricultural value, and less than 5 per cent of it is in cultivation. The remaining forest consists of scattered yellow pine, with some pine reproduction. Native grasses are abundant. The cultivated part of the type comprises areas favorably located with respect to springs or to small streams which may be diverted for irrigation. Early crops may be grown under intensive farming methods, but late-maturing uncultivated crops are seldom successful.

The selling value of much of this type is apparently not based upon its present productive capacity. All of it is fairly well located with respect to markets and transportation facilities, but there is very little demand for land of this character at the present time. It is held at prices ranging from $50 to $100 or more an acre, the higher figures applying to land near Spokane.

Irrigation is essential to the development of this type. It lies too high above the river channels for stream waters to be available without too great a lift by pumping. Irrigation may be accomplished by taking water from the stream courses a long distance back. The soil is adapted to all the common crops when properly handled under irrigation.

The table below gives the results of a mechanical analysis of a sample of the soil of the Springdale gravelly loam:

Mechanical analysis of Springdale gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551342	Soil	5.5	6.0	2.5	13.0	18.8	43.9	10.2

SPRINGDALE COARSE SANDY LOAM.

The Springdale coarse sandy loam as mapped in this survey includes a number of variations in texture, gravel content, and topography. The more extensive and pronounced of these are differentiated as gravelly, rolling, and light phases.

The surface soil of the typical Springdale coarse sandy loam is a light-brown coarse sandy loam extending to a depth of 6 to 8 inches.

The subsoil consists of a light yellowish brown to yellow, loamy coarse sand underlain at about 15 inches by yellowish-gray to gray, stratified sands and fine gravel, a deep substratum of which underlies the type. The coarse sand grains in the surface soil are usually quite well rounded and consist mainly of basaltic material. The surface soil contains some fine gravel, but no medium gravel or coarser fragments. In virgin areas it has a quite compact structure, but it becomes mellow upon cultivation. It is deficient in organic matter, and the subsoil and substratum are very porous. In some places the type is much more gravelly than in others, grading toward the gravelly phase. On local alluvial fans and on the lower terraces the coarse material is sharp instead of rounded.

The coarse sandy loam is the most widely distributed and the most extensive of the Springdale soils. It occurs throughout the terrace portions of the northern and central parts of the county, the largest areas lying immediately north of the city of Spokane. It is an extensive type near the junction of Lake Creek with Latah Creek, south of the city. Several areas of considerable size are mapped southeast of Elk. The type is found on the north side of the Spokane Valley east of the city and in the valley of Dragoon Creek. It is associated with other Springdale soils and with the Garrison and Clayton series.

A terrace topography is typical of this soil, which has a level to very gently undulating surface. The included alluvial-fan areas are very gently sloping. Steep terrace fronts mark the descent to the lower lying types. The elevation usually ranges from 1,900 to 2,200 feet above sea level, but in the valley of Dragoon Creek, between Deer Park and its junction with the Little Spokane River, the type occupies somewhat lower terraces than elsewhere. The soil here consists mainly of sharp particles of granitic rock, and the substratum, though porous, does not have the coarse rounded material typical of the substratum of this series. The type has practically no run-off in any of the areas, but the internal movement of moisture is so free that drainage is excessive.

The Springdale coarse sandy loam is the most important type of the series. The areas range from small to large, and are numerous, but the type does not predominate in any township. It is difficult to estimate the percentage in cultivation on account of the scattered distribution of the type, but the proportion does not exceed 15 per cent. As a rule the cultivated area represents the parts of the type best adapted to cropping, water supply being the important factor.

The forest stand is in various stages of removal. The typical scattered yellow pine has for the most part been logged off, and the forest cover now consists mainly of pine reproduction in various

stages of growth. Native grass is usually abundant and affords some pasturage for stock. The cost of clearing is not excessive.

The cultivated area consists of small to medium sized fields throughout the type. The only fairly large tract in cultivation is included within an irrigation project near Deer Park. Without irrigation the type is used for grain, hay, potatoes, and other crops grown for home use, and to a lesser extent for intensively cultivated crops in small fields. Under irrigation its chief use is in growing fruit, with some intertilled crops. The type is not highly regarded by the farmers in general, on account of its droughty character. Late-maturing crops usually suffer from a lack of moisture and sometimes from frost. Early crops, especially cultivated ones, are more uniformly successful.

Winter varieties of wheat give the higher yields, ranging from low to medium. Oats are an uncertain crop, usually giving rather low yields. Potatoes do well in favorable seasons. When given plenty of water apple trees make a fairly satisfactory growth and produce moderate yields of a good quality of fruit. Practically all the common crops give profitable yields under intensive irrigation farming.

As some of the type is well located and some of it remote from transportation lines, its sale value has quite a range. Farms with only small clearings are held at $25 to $75 an acre. Land under irrigation and set to orchard is held at upward of $500 an acre.

The plowing under of green-manure crops would increase the low content of organic matter in this soil and aid it in holding moisture. Only a small percentage of the type is now under irrigation. Sufficient water is not available at present, and it is doubtful whether it could be obtained by gravity systems or pumping at a reasonable cost.

Springdale coarse sandy loam, gravelly phase.—The Springdale coarse sandy loam, gravelly phase, consists of a light-brown coarse sandy loam containing a large amount of fine gravel and extending to a depth of 6 to 8 inches, where it is underlain by a light yellow coarse sandy loam with fine gravel which at 20 to 24 inches rests upon a bed of gray fine gravel and sand. The latter material extends to a depth of 3 feet or more, and continues as a substratum to the depth of many feet. A characteristic feature of the phase is the quantity and the small size of the gravel; medium gravel, cobbles, and bowlders seldom being encountered. The soil in its natural state has a compact structure, but when broken it is mellow. The lower subsoil and substratum are very porous, and the surface soil and subsoil are deficient in organic matter. Variations in texture are fine rather than coarse, and the boundaries drawn with the typical Springdale coarse sandy loam are sometimes arbitrary.

This phase occurs in the Little Spokane River Valley between Milan and Dartford. It is most extensive on the east side of this valley between Deadman and Deer Creeks. Other areas are mapped north of Chester and south of Edgecliff. The phase occupies portions of the highest terraces in the north-south trough or valley of which the Little Spokane River Valley is a part. It has a nearly level surface, from 1,900 to 2,100 feet in elevation. The porous character of the soil material results in excessive drainage.

This is a moderately extensive soil, but less than 10 per cent of it is used for crops. The remainder has a forest growth of yellow pine and pine reproduction, with native grasses which afford pasturage part of the year. In some places small fields which were cleared and at one time farmed have been abandoned. Late-maturing crops have not been very successful on account of the droughty character of the soil, but intensively cultivated early-maturing crops do fairly well. Rather low yields of grain are obtained. None of the land is irrigated.

Areas of this soil are well located with respect to transportation lines, but it is in little demand for farming purposes. Its sale value depends upon the forest stand and the character of the associated soils, and ranges from $40 to $100 an acre.

Owing to the porous character of the soil and substratum, irrigation is necessary for best results, but irrigation by pumping is impracticable and the high elevation makes the cost of a large-scale gravity system excessive. The tributary streams do not have a sufficient flow to afford water for a large acreage, even with storage systems. The phase under present conditions is best adapted to the production of forest crops and pasturage. Here and there small areas favorably located with respect to springs or streams may be developed, as under irrigation the phase is adapted to all the intensively farmed crops of the region.

Springdale coarse sandy loam, light phase.—The light phase of the Springdale coarse sandy loam consists of a light-brown loamy coarse sand extending to a depth of about 8 inches, and underlain by a brownish-yellow to yellow loamy coarse sand which at 12 to 15 inches rests upon gray coarse sand and fine gravel. The latter material continues to many feet in depth. Gravel and other rock fragments are usually absent. This phase really represents a loamy coarse sand, whose extent was not deemed sufficient to warrant the establishment of a separate type.

The largest areas of the light phase occur northwest of Spokane. The surface is terraced, but in detail it is wavy or very gently undulating, probably due in large part to the action of winds on the light-textured material. Drainage is excessive.

Nearly all of this phase remains in forest. A small shrub, locally called "buckbrush," is abundant. The soil is too loose and droughty for successful cultivation except under irrigation. It is used mainly for pasture.

Springdale coarse sandy loam, rolling phase.—The rolling phase differs little from the typical Springdale coarse sandy loam except in topography. The soil is slightly lighter in texture, and more excessively drained. It consists of areas which have suffered greater erosion than those of the typical soil. The phase is almost wholly covered by a scattered forest and is used to some extent for pasturage. Almost none of it is in cultivation. Under irrigation it may be used for crops, but it requires greater care in handling than the level portions of the type.

In the following table are given the results of a mechanical analysis of a sample of the soil of the Springdale coarse sandy loam, gravelly phase:

Mechanical analysis of Springdale coarse sandy loam, gravelly phase.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551344	Soil	49.9	9.8	1.3	3.5	6.6	23.1	5.6

SPRINGDALE SANDY LOAM.

The Springdale sandy loam consists of about 8 inches of brown or light-brown, friable sandy loam underlain by a yellowish-gray gravelly sand or sandy gravel to a depth of 3 feet or more. The substratum is made up of loose, porous material. The type carries little gravel on the surface and there are almost no cobbles or bowlders within the 3-foot section. The soil is of rather coarse sandy loam texture but is somewhat finer than the Springdale coarse sandy loam. It is loose and porous and low in organic matter.

An area of Springdale sandy loam covering several square miles lies about 3 miles east of Deer Park, in the northern part of the county. Numerous areas occur throughout the terrace portion of the county in association with the other Springdale types and the Clayton and Garrison soils.

The surface is smooth and seldom interrupted by drainage courses. All the precipitation is carried away internally and there is a tendency toward excessive drainage.

Aside from the fairly large area east of Deer Park, this is not an important type agriculturally. Possibly 10 per cent of it is cleared and farmed. The remainder has a forest cover typical of the Springdale series. The greater part of the merchantable timber has been

removed and the native grasses furnish some grazing. The area dry-farmed is used for the production of grain, hay and potatoes. The irrigated acreage is almost wholly in apple orchards, in some of which intertilled crops are grown. The type is well located with respect to means of transportation and it is regarded as moderately productive, but it is too droughty for the profitable production of crops without irrigation. Winter wheat is the best grain crop.

With proper care apple orchards make a good growth and produce fair yields of fruit. The trees are young, and there is little basis on which to estimate the possibilities of the successful production of fruit as they become older.

This land generally sells for $40 to $75 an acre. Orchard tracts are held at upward of $500 an acre.

Irrigation is necessary for the fullest development of this soil and, except for part of the area near Deer Park, water is not available. A few areas lie so that they could be irrigated from streams and others could be supplied by the use of storage systems.

SPRINGDALE FINE SANDY LOAM.

The Springdale fine sandy loam consists of about 6 inches of light-brown fine sandy loam underlain by light yellowish brown fine sandy loam which at 12 to 15 inches rests upon light yellowish gray gravelly loamy sand. Below a depth of 3 feet the latter becomes much coarser, and continues so for many feet. Typical areas have practically no bowlders on the surface and very few within the soil, but in places there is some scattered rounded gravel. In its natural state the soil is somewhat compact, but it becomes mellow upon cultivation. Both subsoil and substratum are loose and porous. The soil is deficient in organic matter.

Two areas of this type cover about 3 square miles in T. 29 N., R. 42 and 43 E. Another lies on the east side of Eloika Lake. The type occurs also in the Little Spokane Valley from the north county line to a point near Dartford, in association with the stony phase and with other types of the same series. It occupies a portion of the extensive outwash and glacial lake plain in the northern part of the county, which lies 2,200 to 2,300 feet above sea level. The northern half of the large area has a gently undulating topography. In the Little Spokane Valley the type occupies stream terraces, and is nearly level. It is not traversed by drainage courses, its porous structure allowing excessive internal drainage.

The Springdale fine sandy loam is one of the less important types of the series. Probably not more than 10 per cent of the type is used for crops, the remainder supporting a forest growth of scattered yellow pine with some pine reproduction. Nearly all the large trees have been removed, and native grasses usually are fairly abundant.

The agricultural value of the type is relatively low. It is droughty and needs intensive farming under irrigation to insure profitable yields, but is not favorably situated with regard to a water supply. Subsistence crops typical of small clearings in a fairly recently settled section are grown. Some income is obtained from the sale of wood. At the present time the value of logged-over land of this type ranges from $35 to $60 an acre.

Springdale fine sandy loam, stony phase.—The stony phase of the Springdale fine sandy loam, which is indicated on the map by stone symbols, includes terrace areas whose surface is so thickly covered with bowlders of various sizes that their removal is difficult and expensive. The stones seem to be confined largely to the surface.

This phase occurs mainly in the Little Spokane River Valley in association with the typical Springdale fine sandy loam and other types of the series. It is associated with the Waits stony loam, and at least part of the bowlders may be ice-laid. The surface differs from the morainic topography of the latter type, being practically level. Drainage is by internal means and is excessive. None of the phase is in cultivation, its sole use being for pasture.

In the following table are given the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the typical Springdale fine sandy loam:

Mechanical analyses of Springdale fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551351	Soil	4.2	12.4	6.6	23.2	17.0	30.2	6.2
551352	Subsoil	7.0	13.3	6.4	27.6	18.1	22.6	4.7
551353	Lower subsoil	9.6	15.2	7.6	31.6	15.3	16.6	4.1

GARRISON GRAVELLY LOAM.

The surface soil of the Garrison gravelly loam is a dark-brown to dark grayish brown loam, of silty texture, extending to a depth of 6 to 8 inches. The subsoil consists of a brown gravelly loam or sandy loam underlain at 12 to 14 inches by yellowish-brown sandy gravel, or gravel with interstitial sand, which extends to a depth of 3 feet or more. The substratum is a bed of gravel, cobblestones and sand many feet in depth. In places rounded bowlders of small to medium size occur on the surface and to a small extent within the soil, and areas in which they are abundant are differentiated as a stony phase.

The gravel content is large and consists mainly of well-rounded, medium-sized fragments of a variety of rocks, including granite,

schist, and quartzite. The surface soil in virgin areas and in uncultivated fields is firm and hard when dry, but upon cultivation it becomes loose and mellow. The organic content is fairly high. The upper subsoil has a fairly compact structure, which aids the type in holding moisture. There is a tendency for the gravel in the soil to accumulate on the surface after continued cultivation.

This is probably the most uniform soil type in the county, but it includes a few variations. In color there is a range from medium dark brown to nearly black. The browner variations occur near the margin of adjacent forested soils, where scattered trees have encroached on the original prairie. The darker colored areas occupy shallow troughs or depressed situations near the foot of terrace fronts. When wet the soil appears black. Except in a few places, the soil grades toward a gravelly silt loam or silty loam. Normally the soil carries a very low percentage of material intermediate in size between medium and fine gravel and silt and clay. A few hundred acres are included in which the gravel is of finer size than typical, but which otherwise conform to the general character of the type.

The Garrison gravelly loam is confined to the valley of the Spokane River east of the city of Spokane. It is almost the only soil type on the valley floor, which is about 18 miles in length and from 2 to 6 miles in width. Practically the only associated types are the sandy loam members of the Garrison series, which occur on the included alluvial fans deposited where streams emerge from the uplands. A few areas occur in the Spokane River Valley below the city and in the Little Spokane Valley.

The Garrison gravelly loam covers an extensive plain whose surface shows remarkably few irregularities. The most conspicuous are a few low terrace fronts which sometimes extend for a number of miles. In addition there are evidences of a few old stream channels. The Spokane River flows in a very narrow trough from 25 to 40 feet or more below the level of the plain, and is not bordered by any recent alluvial deposits within this type. The elevation of the valley floor ranges from 2,100 feet near the Idaho line to 1,900 feet near the city of Spokane.

The Spokane River, the only watercourse traversing this soil, receives no surface drainage from it, a number of streams from the upland on either side disappearing upon reaching the valley floor. Internal drainage is so free that the type is excessively drained.

This is the most extensive of the glacial-terrace soils, and one of the most extensive types in the county. It is practically confined to one large area. The type was at first used for grazing, but this soon gave way to annual crops, and at present very little of the native cover of bunch grass remains. Nearly all of the type is in cultivation except that portion within the city of Spokane and a number of residential dis-

tricts and small towns in the valley. All parts of the type have quick access to markets. It is traversed by three steam and two electric lines, in addition to which there are many miles of improved wagon roads. The type occupies the most thickly populated section of the county, and several irrigated districts are within its limits. The upper subsoil compacts and enables the type to hold moisture better than its texture and structure would lead one to conclude. Tillage is comparatively easy, as the gravel does not seriously interfere. Water is obtained for irrigation by gravity systems and by pumping.

Wheat is the chief crop on the nonirrigated farms, and fruit on the irrigated portion of the type, which amounts to approximately 10,000 acres. In an average season early maturing crops may be safely grown without irrigation. Yields of wheat range from 10 to 25 bushels per acre.

Over 90 per cent of the orchard acreage is planted to apples, and the remainder to pears, cherries, and peaches. Some owners grow intertilled crops, while others grow such crops in only a portion of the orchard. The intertilled crops are potatoes, tomatoes, peas, beans, other vegetables, red and black raspberries, strawberries, gooseberries, blackberries, and currants. In a few cases alfalfa is grown.

The irrigated farms are small, rarely exceeding 40 acres. In some cases the owners devote their whole attention to farming, while in others the owner resides on the farm but works in the city or a nearby town; occasionally all of the labor is hired and the owner lives elsewhere. The small-fruit, vegetable, and truck crops are marketed largely in Spokane. Apples are packed at nearby points and shipped to eastern markets. Open ditches are used in the gravity systems of irrigation and underground pipes in the pumping systems. Electrical power is used for pumping.

Large quantities of farm crops, fruit, and truck are produced on this soil, and it supports a large population which would not be possible without irrigation. Land values show a wide range. Small tracts in bearing orchard are valued at $300 to $800 an acre, with a slightly lower price for young orchards. Undeveloped land near the towns and city are frequently valued so highly that their use for general farming is precluded. Farms in the grain-producing section usually have prospective value, in excess of what their productive capacity under dry-farming methods warrants. A considerable acreage of the type lies within the city of Spokane or its suburbs, and the value is based on other than agricultural factors. The present exchange of land of this type is not active.

This type is adapted to the production of all the common crops under intensive methods of farming and irrigation. There seems to be very little extension of the irrigated area at the present time. Practically no new orchards are being planted, and some of the old

ones are neglected. Land values are so high that profitable returns can not be made on the investment in many cases. Lower valuations placed upon undeveloped land would probably promote its intensive development and increase the total production of crops. Artificial drainage is not necessary in the irrigated districts on account of the porous subsoil and substratum, and there are no indications of accumulation of alkali.

Garrison gravelly loam, stony phase.—A stony phase of the Garrison gravelly loam is indicated by stone symbols on the map. It conforms in general to the typical soil except that the surface is so thickly strewn with bowlders of various sizes, that the agricultural value is lowered. That bowlders have been very abundant on certain portions of the Garrison gravelly loam now in orchards is indicated by the piles of stones along the roadways and between fields. Such areas would doubtless have been classed as the stony phase of this type before clearing. The present stony areas can be cleared of stone and put under cultivation, but none of the phase is at present in cultivation, its sole use being for pasture.

In the following table are given the results of a mechanical analysis of a sample of the soil of the typical Garrison gravelly loam:

Mechanical analysis of Garrison gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551356.....	Soil.....	12.6	7.4	1.8	6.6	11.4	45.6	14.4

GARRISON COARSE SANDY LOAM.

To a depth of about 8 inches the Garrison coarse sandy loam is a dark-brown or dark grayish brown, coarse sandy loam, of loose structure and of moderately high organic content. This grades quickly into the subsoil, which consists of a brown, loose, loamy coarse sand underlain at about 15 inches by a light brownish gray coarse sand which extends to a depth of 3 feet or more and gives way to still coarser material in the substratum. The type carries no large rock fragments or gravel.

There are no large areas of this type. It occurs in isolated areas ranging from 25 to 300 acres on each side of the Spokane River Valley east of the city of Spokane. One area is mapped about 2 miles north of Colbert. The type is either level or very gently sloping. It lies 2,000 to 2,100 feet above sea level. The normally light precipitation is all absorbed by the type, and there is no run-off. The internal movement of moisture is so thorough that crops may suffer in the summer months.

The Garrison coarse sandy loam is an unimportant type. It seldom occupies more than a small part of farms, but its location and original prairie character have favored its use for crops, and nearly all of it is now in cultivation. It is regarded as a productive and desirable soil when properly farmed. It holds moisture better than the forested types of similar character, on account of its higher content of organic matter. A wide range of crops is grown, as the greater part of the type is included in fairly small farms. The leading crops are wheat, fruit, potatoes, vegetables, and other truck. Yields range from medium to good.

This type of land ranges in selling value from $75 to $200 or more an acre, according to the state of improvement.

Garrison coarse sandy loam, heavy phase.—The surface soil of the heavy phase is a dark-brown coarse sandy loam, 6 to 8 inches in depth and somewhat more silty than that of the typical Garrison coarse sandy loam. The subsoil consists of a lighter brown loamy coarse sand underlain at 12 to 15 inches by grayish-brown to gray sands and fine gravel which extend to a depth of 3 feet or more. Coarse, porous stratified deposits continue to a depth of many feet. The surface soil and subsoil are free from stone. The soil has a friable structure and is fairly high in organic matter while the subsoil is loose and open. When moist, some areas of the phase assume a dark-gray or black color.

This phase is most extensive in Sunset Prairie, where it covers an area of several square miles south of Deep Creek. Another area is mapped about 2 miles south of Greenacres. Two small areas occur in T. 24 N., R. 43 E, to the south of Spokane.

The phase has a terraced topography and lies 2,300 to 2,500 feet above sea level. The surface of the large area is slightly undulating, in contrast to the level surface of most of the terrace areas. Drainage is internal, and there is a tendency toward excessive subdrainage.

The Garrison coarse sandy loam, heavy phase, is a fairly important soil on the Sunset Prairie, where some entire farms are located upon it. Approximately 85 per cent of it is farmed to annual crops, while the remainder is used for pasturage. The soil is well located with respect to transportation lines and markets, but settlement is rather sparse. The tendency toward excessive drainage, resulting in the injury of late-maturing crops, has retarded its development. Wheat is the chief crop. Subsistence crops are grown on the remainder of the cultivated area. Yields of wheat range from 10 to 25 bushels per acre, according to the season. Other crops give medium yields. Summer fallowing is a common practice with some farmers, while others plow in the fall and sow spring wheat.

Areas of this phase do not command a ready sale at the present time. It is valued at prices ranging from $50 to upwards of $100 an acre.

Irrigation is essential for best results with this soil, especially in fruit growing. Profitable yields are obtained without irrigation, but crops are subject to great uncertainty. This soil is better adapted to intensive than to general farming. Attention should be given to increasing its supply of organic matter.

In the following table are given the results of mechanical analyses of samples of the soil of the typical Garrison coarse sandy loam and of the soil and subsoil of its heavy phase:

Mechanical analyses of Garrison coarse sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Typical soil:		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551359.....	Soil.....	5.8	37.9	10.8	11.9	7.4	19.7	6.6
Heavy phase:								
551366.....	Soil.....	22.0	16.2	2.0	6.6	12.0	32.9	8.3
551367.....	Subsoil.....	35.7	16.4	2.2	11.5	9.6	20.1	4.6

GARRISON SANDY LOAM.

The soil of the Garrison sandy loam is a dark-brown to dark grayish brown, medium sandy loam, 6 to 8 inches in depth. The subsoil is a brown, light sandy loam extending to a depth of 3 feet or more. The substratum consists of loose, coarse sand and gravel, many feet in thickness. The soil is fairly well supplied with organic matter and has a friable structure. The subsoil and substratum are loose and porous.

In some places the soil has a dark-gray color which becomes nearly black when moist. In others the lower subsoil may be very light brown or grayish. Occasional small areas of fine sandy loam texture are included with this type.

The Garrison sandy loam is confined to terrace areas east and south of Spokane. Most of the type has a characteristic terraced topography, while the remainder has a very gently sloping surface typical of alluvial fans. All of the type is well drained by internal means.

This soil was originally prairie except for the margins of a few areas, where the forest has encroached to a slight extent. Practically its entire area is cultivated, all the common crops being grown. Grain and fruit probably lead in acreage. Some of the type is intensively farmed to truck crops.

Markets are easily accessible, and the soil is regarded as productive and desirable, especially for intensive farming. Land values depend very much upon the state of development and the kind of farming, and range from $75 to $200 an acre.

The following table gives the results of a mechanical analysis of a sample of the soil of the Garrison sandy loam:

Mechanical analysis of Garrison sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551362.....	Soil.....	4.7	16.0	9.7	33.1	9.3	21.3	6.0

GARRISON FINE SANDY LOAM.

The Garrison fine sandy loam consists of a dark-brown, fine sandy loam, about 8 inches deep, underlain by a brown, light-textured fine sandy loam, which extends to a depth of 3 feet or more. Stratified deposits of as fine or finer texture, with an occasional stratum of coarser material, continue to a depth of several feet. Rock fragments are uncommon in the soil and subsoil material. The soil has a rather high organic matter content. Both the soil and subsoil have a slightly porous structure.

There are included with this type certain small areas occurring either as alluvial fans or in slightly depressed positions, in which the texture of the surface soil ranges from a very fine sandy loam through a loam to silt loam. The subsoil and substratum in most cases conforms to the coarse porous material typical of the series.

The valley areas, though comprising by far the greater part, are not properly Garrison material, in that their subsoil and substratum are too fine textured and that they have apparently been derived to a large extent by erosion of the adjacent fine-textured loessial soils of the Palouse series.

The type occurs mainly in the valley of Latah or Hangmans Creek, in the central part of the county, where it occupies low terraces which are above overflow and well drained internally. The creek follows a well defined channel, usually without first bottoms and from 5 to 15 feet below the surface of the type. Two areas are found along North Pine Creek in the southern part of the county. Other small areas are located on the extensive prairie of the Spokane Valley, east of Spokane, and occupy either alluvial fans or have a slightly depressed position, though they are adequately drained.

The Garrison fine sandy loam is of moderate extent. All of it is prairie except along the border where a few trees have encroached from adjacent wooded areas. The type is in cultivation to wheat, potatoes, fruit, and truck. Medium to good yields are obtained.

The sale value ranges from $50 to $100 or more an acre, depending upon its location, use, and the character and value of the associated soils.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the Garrison fine sandy loam:

Mechanical analyses of Garrison fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551369	Soil	1.2	9.8	9.6	39.0	17.6	14.3	8.7
551370	Subsoil	.7	12.4	13.0	40.6	17.1	10.4	5.7

MISSION FINE SANDY LOAM.

The Mission fine sandy loam consists of 6 to 8 inches of yellowish-brown or light-brown fine sandy loam, underlain by pale to light yellow fine sandy loam to a depth of 3 feet or more. Stratified, fine-textured material continues to a depth of 25 feet or more. No rock outcrops or coarse rock fragments are found. Both soil and subsoil have a rather loose structure. The content of organic matter in the soil is low. As mapped, some areas of very fine sandy loam texture are included.

This type occurs in several of the lateral valleys tributary to the main north-south valley or trough which occurs in that part of the county north of the Spokane River. An area also occurs along Coulée Creek, in T. 26 N., R. 41 E. The largest area is mapped in the valley of Deep Creek in T. 27 N., Rs. 43 and 44 E. The Mission silt loam is associated with the fine sandy loam and occurs on the same level.

The surface is smooth except near the main streams, which flow through narrow bottoms from 10 to 25 feet below the general level of the type. Drainage courses do not reach to all parts, as there is no run-off, nearly all the type being adequately drained by percolation.

This soil is of small extent, and only about 25 per cent of it is cleared and farmed. The remainder supports a growth of fir, tamarack, and pine, with abundant underbrush. The clearings are for the most part small and fairly recent. The type is accessible and is easily cultivated, and it is desirable for both general and special crops. Grain, hay, and potatoes are the leading crops. Dairying and stock-raising receive very little attention. The soil would be improved in productiveness by turning under liberal amounts of organic matter.

There is little change taking place in the ownership of this land at present. Its sale value is about the same as that of the Mission silt loam, ranging from $50 to $100 an acre.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the Mission fine sandy loam:

Mechanical analyses of Mission fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551371	Soil	0.4	5.7	5.4	27.9	23.6	30.9	6.2
551372	Subsoil	.1	2.3	2.3	24.2	30.5	37.4	3.3

MISSION SILT LOAM.

The surface soil of the Mission silt loam is a light yellowish brown silt loam extending to a depth of about 8 inches. It is deficient in organic matter, and compact and hard in structure in its natural state, but is easily maintained in good tilth under cultivation. When dry the surface material assumes a grayish color. The subsoil is a light-yellow silt loam of fairly friable structure extending to a depth of 3 feet or more. Below this, stratified silts and clays continue to 25 feet or more in depth. The type is free from rock outcrops and from stones. It is similar to the Hunters very fine sandy loam except in color and to a slight degree in texture.

This type does not have a wide distribution. It occurs in the valleys of Deep and Deadman Creeks near the place where these streams emerge from the residual hills into the wider valley floor. Practically all of it is confined to Ts. 26, 27, and 28 N., R. 44 E. The only associated type on the same level is the Hunters very fine sandy loam of the Peone Prairie.

The surface is flat except immediately along creeks flowing in narrow bottoms 10 to 20 feet or more below the general level, where some erosion has taken place. Elsewhere practically all of the precipitation is absorbed by the soil, and there is adequate internal drainage under the existing climatic conditions. The type lies approximately 2,000 feet above sea level.

The Mission silt loam is of small extent, but 75 per cent of it is used for crops. A few valley farms are partly situated on this type, which in some cases comprises the only cultivated portion of the farms. The native forest cover consists of fir, tamarack, pine, and underbrush. The type is quite easily accessible, has a favorable topography and water supply, is moderately retentive of moisture, and is regarded as a fairly productive and desirable soil for general crops.

Small grains and grasses are the chief crop. Timothy leads among the grasses. Potatoes are grown to some extent. Stock raising and dairying are unimportant industries. Fairly good yields of all crops are usually obtained, though late-maturing crops are sometimes injured by drought or by early fall frosts. Land of this type is valued at $50 to $75 an acre.

Yields on this soil are sometimes lowered by lack of moisture, and the production would be materially increased under irrigation. The surface of most of the type is well adapted to irrigation farming, and water could be made available by the construction of storage dams higher up along the streams. Increasing the normally low organic content of the soil by plowing under green manure and winter cover crops would make the type more retentive of moisture and at the same time more productive.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the Mission silt loam:

Mechanical analyses of Mission silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551373	Soil	0.2	0.9	0.8	4.5	22.2	61.3	9.6
551374	Subsoil	.2	.6	.7	5.4	25.9	38.5	28.6

CLAYTON SANDY LOAM.

The surface soil of the Clayton sandy loam is a yellowish-brown to pale-yellow light sandy loam, 6 to 10 inches in depth. The subsoil is a yellow or grayish-yellow light sandy loam to loamy sand extending to a depth of 3 feet or more. Material of similar character usually continues for several feet, but fine-textured compact deposits occur in the deeper substratum. The type is free from rock outcrops and stones. It is deficient in organic matter, both surface soil and subsoil having a loose, porous structure.

The largest development of this type is in T. 28 N., R. 42 E., south and west of Dragoon Creek. It is also fairly extensive on the high terrace southeast of Elk.

The surface is moderately level and traversed by few drainage channels. These are fed by springs, as practically all the precipitation is absorbed by the soil and the excess disposed of by percolation. The internal drainage is rather slow in the spring months, when the type is receiving the greatest amount of precipitation. The substratum sometimes becomes saturated with cold water, in which case the type warms up slowly.

The Clayton sandy loam is of small extent, and only about 15 per cent of it is used for crops. It was originally very thickly forested with fir, tamarack, and pine, but the merchantable timber has been removed from nearly all the type, and from part of it the fuel wood has been cut in addition. The type is very thinly settled, and the clearings are small. It is regarded as moderately productive, but the distance from good markets and the difficulty of clearing have retarded development.

Subsistence crops are grown most extensively. Wheat and potatoes are a source of income on some farms. Cattle raising is carried on to some extent. A small acreage has been set to fruit trees, but these are affected to some extent by extremes of weather and damage is sometimes caused by frosts during the growing season.

The present valuation of this type is probably higher than the stage of development and its productiveness warrant. No recent sales are reported, but it is held at $40 to $75 an acre.

Like the other forested soils, this type greatly needs the incorporation of organic matter. Green crops, either legumes or winter cover crops, could be plowed under to supply this material. The soil is subjected to alternate freezing and thawing during the winter months, and there should be some vegetative covering to prevent the leaching away of plant food. The clearing of larger tracts will doubtless improve the air drainage and thus decrease the liability of damage by frosts. The type is apparently best adapted to general farming, with dairying as a side line.

The results of mechanical analyses of samples of the soil and subsoil of the Clayton sandy loam are shown in the following table:

Mechanical analyses of Clayton sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551375	Soil	1.6	15.4	15.2	35.9	10.9	15.2	5.9
551376	Subsoil	1.3	18.2	16.8	33.5	10.6	14.6	4.9

CLAYTON FINE SANDY LOAM.

The Clayton fine sandy loam consists of 6 to 8 inches of pale-yellow to brownish-yellow, loose fine sandy loam, underlain by light-yellow to pale-yellow loamy fine sand or fine sandy loam. The substratum, below 3 feet, consists of fine-textured stratified material extending to a depth of several feet. There are no rock outcrops and only occasional granite bowlders. The type is micaceous. It is markedly deficient in organic matter. Throughout its extent the material grades light rather than heavy, and in places the surface soil is a loamy fine sand. A number of areas of virgin soil, not burned over, have a dark-gray immediate surface soil and a thin, gray subsurface layer.

An area of this type more than 8 miles in length and covering several square miles lies in Ts. 28 and 29 N., R. 42 E., and to the north and south of Half Moon Prairie. An area of some size lies to the northwest of Elk. Small areas are found in association with the other members of the Clayton series and with the Hunters fine sandy loam.

A level surface is typical of this soil. In some places adjacent to sluggish streams which have cut down into the type and now flow in narrow, V-shaped draws or through very narrow bottoms, the surface is slightly undulating, and areas in which the relief has become pronounced are differentiated as a rolling phase. The type lies 2,000 to 2,200 feet above sea level. It is traversed by several well-defined streams, but these have few tributaries and drainage courses do not ramify to all parts of the type. The surface material quickly absorbs all the precipitation, but drainage is retarded by the level surface and the fine texture of the underlying material, so that the water is fairly close to the surface in some seasons. It lowers as the water finds its way downward and laterally to the drainage ways, where it emerges as springs. In the spring season water from melting snows keeps the soil wet and makes it warm up slowly and late.

The Clayton fine sandy loam is the most extensive of the glacial lake-laid soils. It occurs in the terrace portion of the three northern tiers of townships. Development has begun only recently, and in the more newly settled portions of the county the clearings are small. Probably less than 15 per cent of the type is used for crops. The remainder supports a forest cover in various stages of removal. Very little salable timber is left standing. Some tracts have been burned over, while from others the wood has been removed. Originally there was a very dense growth of fir, tamarack, and black pine.

On farms which have fairly large clearings, grain and grass crops are grown quite extensively on this soil. On other farms subsistence crops for home use are produced. Potatoes are a crop of growing importance. Only a few acres have been set out in orchard. Winter varieties of wheat are grown, and yield 15 to 30 bushels per acre. Oats are a somewhat uncertain crop. Potatoes range widely in yield with the soil and climatic conditions. Dairying and stock raising are unimportant sources of income.

Farms with a considerable acreage in cultivation are valued at upwards of $75 an acre. Stump land is held at about $40 an acre. Much of this type is held in large tracts by logging companies which have removed the trees. Most of the type is fairly accessible to transportation facilities.

The burning of the "slashings" and stumps has removed the organic matter from large areas of this soil, and attention should be given to restoring and increasing this material, in which the type is so deficient. Any green crop may be plowed under for this purpose, but as far as possible a legume should be used. Irrigation is not necessary for cultivated and early-maturing crops, but it would be beneficial for late crops. Without a storage system there does not seem to be an adequate supply of water for its irrigation.

Clayton fine sandy loam, rolling phase.—The rolling phase differs from the typical Clayton fine sandy loam only in topography. It occupies areas near drainage courses, which have eroded deeply into the stratified material and whose tributaries have worked back until a rolling surface has developed. It does not present the steeply sloping and gullied appearance of typical eroded areas. Erosion is not active at the present time, so that the phase has a rather mature topography. The small valleys are V-shaped but widely spreading, and the divides are rounded. The soil holds sufficient moisture for a fairly heavy forest growth, but when cleared and exposed to evaporation the drainage is rather excessive.

The phase occurs in association with the typical Clayton fine sandy loam in a number of townships in the northwestern part of the county. A larger portion of the phase, approximately 40 per cent, is farmed than of the type as a whole. Practically the same crops are grown and they give about the same yields as on the typical soil.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the typical Clayton fine sandy loam:

Mechanical analyses of Clayton fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551377	Soil	0.2	4.2	4.3	37.9	24.6	22.8	5.1
551378	Subsoil	.4	2.8	3.1	47.4	24.6	17.7	3.7

CLAYTON VERY FINE SANDY LOAM.

The Clayton very fine sandy loam consists of 6 inches of light-yellow to brownish-yellow very fine sandy loam, underlain by yellow or brownish-yellow very fine sandy loam which at about 18 inches rests upon light-yellow very fine sandy loam. The last extends to a depth of 3 feet or more. The substratum is made up of fine-textured, stratified material which continues to a depth of many feet. The type carries some fine mica flakes. Rock outcrops do not occur, and bowlders or other rock fragments are seldom present. Though the soil and subsoil are moderately compact, they are not sufficiently dense to prevent the movement of water. The soil works into a loose, mellow tilth. The supply of organic matter is deficient.

This type grades toward a silt loam rather than a fine sandy loam, and a large amount of silt usually occurs in both surface soil and subsoil. Areas which are especially flat or rather low lying have a rather gray color, while virgin areas which have not been burned

over have two or three inches of rather dark colored material on the surface, containing organic matter in various stages of decomposition, underlain in places by a thin, light-ashy, gritty subsurface layer.

The largest area of Clayton very fine sandy loam occurs in the extreme northwestern corner of the county, between the glaciated hills to the north and west and the coarser textured types of the same series on the south and east. Several areas are mapped east and southeast of Elk. Others, all small in size, are found scattered over the fine-textured portions of the glacial terraces.

The surface of this type is practically level. It lies at elevations of 2,000 to 2,300 feet. A few drainage courses traverse it in narrow draws, but they have almost no tributaries and the gradient is very low. All the drainage must find its way through the soil to these drainage courses, and the underdrainage is necessarily slow. During the greater part of the year the type is adequately drained, but during the remainder the water table rises and falls and in the early spring is sometimes close enough to the surface to make the soil "cold."

This is not an extensive or widely distributed soil, and not more than 15 per cent of it is cleared and farmed. The remainder supports a forest in various stages of removal. The original growth was a very thick stand of small to medium sized fir, tamarack, and pine. In places forest fires have burned over large tracts. Settlement and development have been slow, largely on account of the forest growth and the distance from market. The clearings are for the most part small, but they are being extended as rapidly as the time and resources of the owners permit. The sale of wood provides a considerable part of the income from farms, and partly pays for the cost of clearing.

General farming on a small scale is the leading type of agriculture on this soil. Dairying and stock raising are slowly developing. Hay, grain, and potatoes are the leading crops, grown mainly for home consumption. Winter varieties of wheat give satisfactory yields in normal years. Oats are grown to some extent, but the yields are sometimes lessened by late seeding and dry weather in the summer months. The type occupies a low, flat position and the clearings are pockets in the forest, so that there is poor air circulation. As a result some crops are often damaged by frosts.

Much of this type lies within large tracts owned by logging companies. The price asked for the land, considering the location and the cost of clearing, has retarded its development. About $40 an acre is the average price for unimproved land. Farms with some improvements sell for $50 to $75 an acre. The exchange of farms on this type is not active.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Clayton very fine sandy loam:

Mechanical analyses of Clayton very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551379	Soil	1.2	2.7	1.0	8.9	25.4	53.2	6.7
551380	Subsoil	.3	1.9	.8	9.9	31.9	47.2	7.8
551381	Lower subsoil	1.0	1.7	.7	8.6	31.2	44.7	12.1

HUNTERS FINE SANDY LOAM.

The Hunters fine sandy loam consists of a dark-brown or dark grayish brown fine sandy loam about 8 inches in depth, underlain by a brown fine sandy loam which extends to a depth of 3 feet or more. The substratum consists of fine textured, stratified deposits which continue to a depth of many feet. Material coarser than sand seldom occurs in this type. It is fairly loose structured, and relatively high in organic matter.

The variations in this type are those typical of prairie areas. Gradations in color occur as the forested soils are approached, and the boundry between this and the related light-brown types of similar texture is often arbitrary. In some places the texture ranges toward a sandy loam, but on the whole it grades light rather than heavy.

This type occurs on the glacial-lake terraces in association with the forested soils of the Clayton and Mission series. The largest area covers all of Wild Rose Prairie in Ts. 27 and 28 N., R. 42 E. An area of considerable size occurs on Half Moon Prairie. The other areas are small and isolated.

The Hunters fine sandy loam has a generally level surface, the only irregularities being a few small drainage ways. It is well drained, most of the rainfall sinking into the soil and into the subdrainage. The type lies at elevations around 2,000 feet above sea level.

Though locally important, the Hunters fine sandy loam is not a widely distributed or extensive soil. All of it is farmed. Originally it supported a growth of bunch grass, and the prairie character of the type and its productiveness favored its early development.

The largest acreage is devoted to the production of winter wheat. Oats, potatoes, and vegetables are minor crops. Yields vary slightly with the season, but crops are seldom seriously damaged by drought. In some years certain crops are injured by frosts. Summer fallowing is practiced by some farmers, but there is little or no systematic crop rotation.

This land sells for $50 to $100 or more an acre, depending on the location and the associated soil.

The suggestions made for the improvement of the Hunters very fine sandy loam apply equally well to this type. It is probably more quickly affected by drought, and consequently would be more greatly benefited by irrigation, but water for this purpose is not at present available.

The results of mechanical analyses of samples of the soil and subsoil of the Hunters fine sandy loam are given in the following table:

Mechanical analyses of Hunters fine sandy loam.

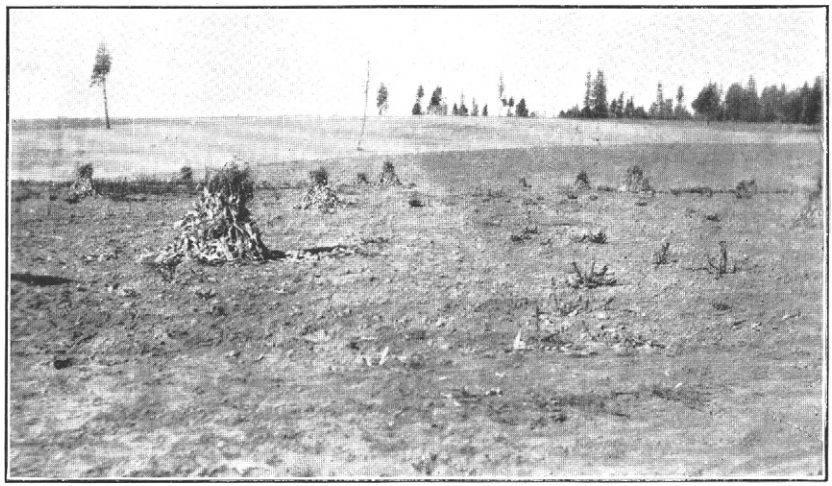
Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551382	Soil	0.0	2.7	7.2	53.1	11.2	19.7	6.1
551383	Subsoil	.1	2.4	6.5	50.1	16.6	20.2	4.3

HUNTERS VERY FINE SANDY LOAM.

The surface soil of the Hunters very fine sandy loam is a dark-brown, mellow very fine sandy loam extending to a depth of about 7 inches. The subsoil is a yellowish-brown very fine sandy loam which extends to a depth of 3 feet or more. The substratum consists of several feet of horizontally stratified very fine sands, silts, and clays. The type is free from rock outcrops and stones. The subsoil seems to be slightly lighter in texture than the surface soil, but the difference may be due to the rather high content of organic matter in the latter. Both soil and subsoil have a moderately loose structure.

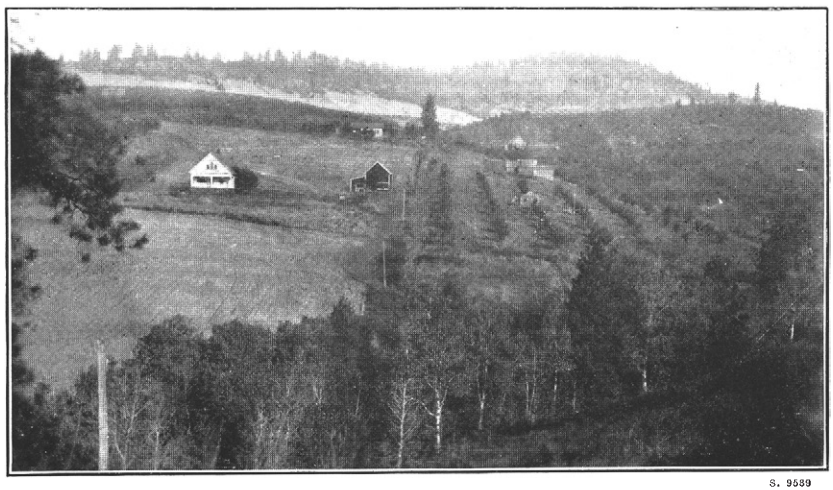
This soil is confined to an area of several square miles on Peone Prairie, about 10 miles northeast of the city of Spokane. The surface is a level plain into which Deadman Creek and a few short tributaries have cut narrow, V-shaped valleys from 25 to 50 feet deep. The type lies at an elvation of about 1,900 feet. All the drainage courses except the main stream carry very little water at any season, so that there is no erosion. The land is well drained most of the rainfall passing into the soil and subsoil.

Although of small extent and limited distribution, the Hunters very fine sandy loam is of considerable importance on account of its favorable location, productiveness, and high state of development. It was one of the first soils to be settled and farmed, and all of the original growth of bunch grass was long ago plowed under. The type is easily cultivated, has a high moisture-holding capacity, and is adapted to the production of a variety of crops, especially wheat. Winter wheat is the only crop grown extensively. It yields 20 to 50



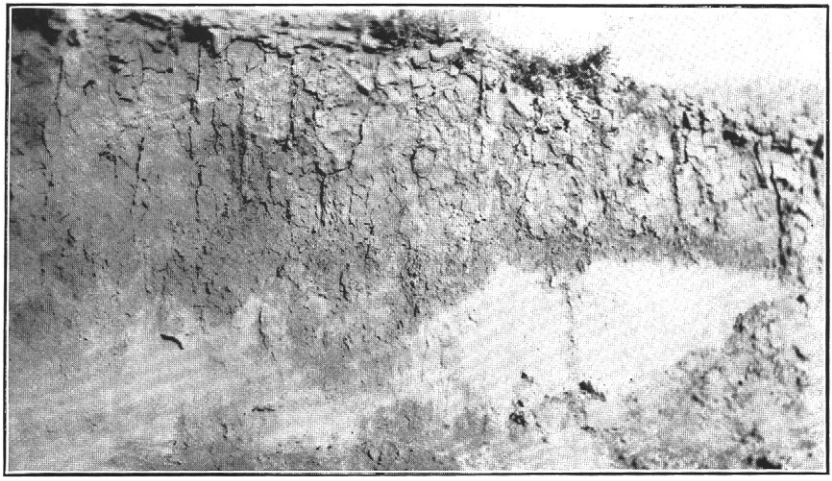
S. 9588

FIG. 1.—TOPOGRAPHY OF THE GREEN BLUFF LOAM.



S. 9589

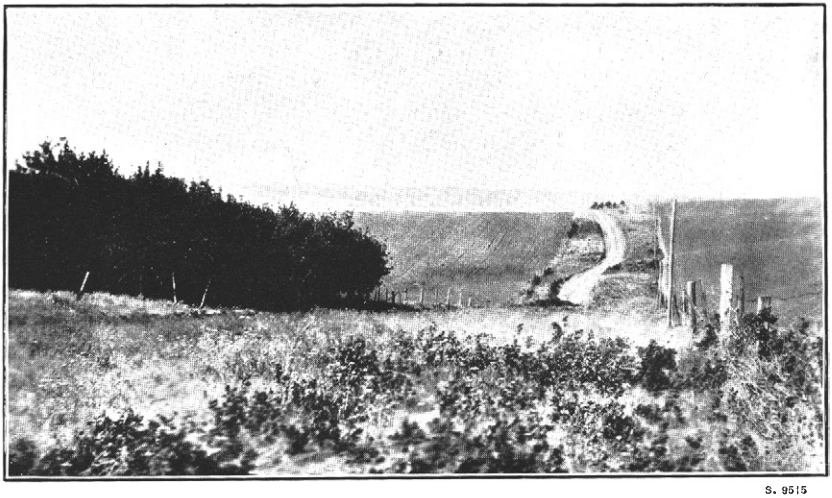
FIG. 2.—VIEW NEAR SHARON STATION, SHOWING TOPOGRAPHY OF THE LIGHTER TEXTURED TYPES OF THE PALOUSE SERIES.



S. 9630

FIG. 1.—TYPICAL SOIL PROFILE IN THE PALOUSE SILT LOAM NORTHWEST OF DEEP CREEK.

Note structure of the surface and subsoil with concentration of lime, indicated by the light color, in the deeper subsoil.



S. 9515

FIG. 2.—TOPOGRAPHY OF THE PALOUSE SILT LOAM.

bushels per acre. Summer fallowing is a common practice. No rotation of crops is possible under the prevailing system of wheat farming.

This land is in demand, but very little of it is for sale. The selling value ranges from $100 to $150 an acre.

The Hunters very fine sandy loam needs a systematic rotation of crops to conserve its productiveness and make possible the annual production of crops. The organic content should be increased. A supply of water for irrigation is not available without a storage system, but under irrigation the type would be adapted to all the intensively farmed crops of the region.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the type:

Mechanical analyses of Hunters very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551384	Soil	0.1	0.0	0.0	10.8	41.9	39.9	6.9
551385	Subsoil	.0	.1	.1	12.6	42.8	39.6	4.7

PALOUSE SANDY LOAM.

The surface soil of the Palouse sandy loam is a dark-brown or dark grayish brown sandy loam extending to a depth of about 6 inches. The soil contains conspicuous amounts of small, sharp particles of quartz or granite the size of coarse sand, and the finer material consists mainly of very fine sand and silt. The subsoil is a compact, heavy, brown loam which continues to a depth of 3 feet or more or is underlain above this depth by either a brown coarse sandy loam or a reddish-brown, compact clay loam, according to the completeness of weathering of the underlying granitic rock. The depth of the fine-earth mantle is from 1 to 5 feet. Outcrops of bedrock are rather common, and many small areas of shallow soil are included, mainly of residual origin. The soil is regarded as derived mainly by the weathering in place of the underlying granitic rocks, but it is probable that in some areas such material has been modified by admixture of wind-borne deposits. The coarser, sharp particles of the surface and subsoil mass are undoubtedly of residual origin. Stones or bowlders are seldom encountered in this soil. It is friable, fairly high in organic matter, and holds moisture moderately well.

The Palouse sandy loam is largely confined to the range of hills south of the eastern part of the Spokane Valley. The largest area lies east and northeast of Valleyford. Others occur on the south and west slopes in association with the Moscow loam and the Palouse silt loam.

The surface is undulating or rolling. (Pl. II, fig. 2.) The type covers rather high slopes on or near the tops of hills and lies from 2,300 to 3,000 feet in elevation. No drainage courses cross it, but it is well drained internally, and where the bedrock is fairly close to the surface the tendency is toward excessive drainage.

This type is of rather small extent and unimportant. All of it was either prairie or, where it borders wooded areas, very sparsely forested. Approximately 50 per cent of the type is cultivated, the remainder being used for grazing. Some areas are rather inaccessible, occupying the tops of high hills whose west and south slopes are usually covered by Palouse silt loam and whose north and east slopes are occupied by the forested soils of the Moscow series.

Wheat is the only crop of importance. The soil is somewhat droughty, but medium yields are obtained. It is farmed in the same way as the lower lying types, has practically the same sale value, and may be benefited by the same methods.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the Palouse sandy loam:

Mechanical analyses of Palouse sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551308	Soil	9.1	11.1	3.1	13.1	19.4	35.3	8.8
551309	Subsoil	4.9	7.2	2.0	8.0	16.2	44.4	17.0

PALOUSE FINE SANDY LOAM.

The surface soil of the Palouse fine sandy loam is a friable, dark-brown fine sandy loam, about 8 inches in depth. The subsoil is a rather loose, light-brown to yellowish-brown fine sandy loam which extends to a depth of 3 feet or more. A substratum of material of similar color and texture, and derived either from old, stratified lake-laid deposits or from fine-textured glacial till, rests upon basaltic bedrock at a depth of 6 to 15 feet or more. The soil is regarded as consisting in part of fine-textured, wind-borne, loessial deposits, but it is probable that old glacial till or glacial-lake sediments of similar texture which appear to underlie the material have entered into its formation. There are some stones in this soil and on the surface, consisting of rounded fragments of granite and quartzite. The type is fairly high in organic matter and has a good moisture-holding capacity.

This soil in its typical development is free from rock outcrop, small areas of shallow soil with outcropping basaltic bedrock being separated as a shallow phase. A slope phase is also differentiated. In places the material grades toward a very fine sandy loam or loam.

The Palouse fine sandy loam occupies prairie areas similar in position and topography to the wooded areas of the Green Bluff loam. It covers the greater part of Fivemile and Pleasant Prairies, a few miles north and northwest of the city of Spokane. Another area covers part of Half Moon Prairie. An area of some importance lies southwest of Saltese Marsh. Several smaller bodies are found south of Spokane in Ts. 23 and 24 N., R. 43 E, and in T. 23 N., R. 44 E. The type is confined to the central part of the county.

In general the surface is level and terraced, conforming to the level surface of the underlying rock. In detail the type may be very gently undulating or sloping. It occupies the prairie portions of shelflike areas on the east side of which rise the residual granitic hills and on the other sides of which there is a more or less abrupt drop of 300 to 400 feet to the lower lying terrace soils. Lateral valleys tributary to the main valleys or troughs separate the type into irregular areas. The drainage is practically all internal, and is adequate at all seasons, the light precipitation being readily absorbed by the soil.

The Palouse fine sandy loam is not a predominant soil in any part of the county, but it is regarded as a very desirable soil for all the general and special crops of the region and practically all of it is under the plow. It was one of the first soils to be put into cultivation. It is accessible, close to market and transportation lines, easily cultivated, and fairly retentive of moisture.

This is probably the most intensively farmed type in the county. Fruit, grain, potatoes, and other vegetables are all grown extensively. The farms are mostly small, so that a variety of crops is grown on a limited acreage. Fruit is the leading crop in the western part of Pleasant Prairie, and grain in the eastern part. Potatoes are one of the most important crops on Fivemile Prairie. Trucking is a source of income on many farms.

Yields of all crops, though varying from year to year according to the season, are usually good. Wheat yields 15 to 35 bushels per acre, and potatoes from 200 to 300 bushels or more. Crops are seldom injured by unseasonable frosts.

In the grain-farming sections the type is handled in the same way as the extensively farmed wheat soils, summer fallowing being a common practice. In the fruit-growing sections the orchards are either given clean cultivation or intertilled crops are grown between the rows. The most intensive methods that the climate will permit are followed on the truck farms. The type as a whole is fairly well farmed, but rotations should be followed more systematically in the grain-producing sections.

Small truck and fruit farms sell for as much as $300 to $500 or more an acre. In the grain-farming section prices average about

$100 an acre. Intermediate prices prevail in the areas where mixed farming is carried on.

Palouse fine sandy loam, slope phase.—The slope phase differs from the typical Palouse fine sandy loam in position and topography. The surface soil and subsoil have in general the same color, texture, and structure. On the whole the phase is shallower, and jagged outcrops of basalt occur in places, with here and there small patches of shallow soil. Rock fragments, mainly basaltic, are more common than in the typical soil.

This phase occurs on slopes facing the Hunters very fine sandy loam on Peone Prairie, in Ts. 26 and 27 N., Rs. 43 and 44 E. It occupies areas between the typical Palouse fine sandy loam or the Green Bluff loam and the soils on the lower terraces. It has a sloping to slightly rolling topography, but there is no run-off, as the type absorbs all the precipitation.

This phase is of small extent and of little agricultural importance. It has always been treeless or nearly so, and practically all of it is cultivated. Some areas are considered desirable for ordinary farm crops, as the soil is easily tilled and holds moisture fairly well.

Wheat is the chief crop. Some potatoes are grown. A small portion of the type is in orchards. Yields of all crops are slightly lower than on the typical Palouse fine sandy loam in normal years.

There are few farms on this soil, and its sale value depends upon that of the more highly developed associated types.

Palouse fine sandy loam, shallow phase.—The shallow phase includes small areas of Palouse fine sandy loam usually occurring near the break in topography to the lower lying types. The areas are small and unimportant. They differ from the typical Palouse fine sandy loam mainly in the closeness of the underlying rock, which is frequently found within the 3-foot section. Flat outcrops of rock are fairly common.

The surface is nearly level, and the closeness and level character of the underlying rock sometimes cause slow internal drainage in the spring season. Grain farming is the leading type of agriculture, and fair yields are obtained in favorable years.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the typical Palouse fine sandy loam:

Mechanical analyses of Palouse fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551336	Soil	1.4	6.2	5.1	19.0	23.6	34.8	8.9
551337	Subsoil	.7	6.6	7.0	20.8	24.0	36.9	3.2
551337x	Lower subsoil	1.1	7.6	6.0	22.5	25.0	31.0	6.7

PALOUSE LOAM.

The Palouse loam consists of a dark-brown loam, about 10 inches in depth, underlain by a brownish-yellow to yellow fine sandy loam or loam extending to a depth of 6 feet or more. Road cuts and other exposures in the type indicate that it is underlain by very compact, reddish-brown material similar to the deep substratum of the Palouse and Helmer silt loams. Medium-sized granitic and basaltic bowlders occur on the surface very scatteringly, but uniformly, and there are also a few of slate and quartzite. Some of the bowlders show glacial striations. Within the soil the percentage of gravel, cobbles, and bowlders is very low. The occurrence of the occasional glacial erratics, however, indicates that the areas were at one time covered either by glacial ice or by glacial waters in which the bowlders were floated in bergs or other fragments or blocks of glacial ice. It is probable that the loessial material has been modified by glacial deposits, but to what extent is difficult to determine, and the type as mapped may include some material mainly of glacial ice-laid or water-laid origin. There are no outcrops of bedrock.

This is a fairly uniform soil, with little or no variation in color, texture, or structure. The texture closely approaches a silt loam similar to that of the Palouse silt loam in the southern part of the county, but the type contains more grit and is more friable under dry conditions. It differs from the Palouse silt loam also in the presence of bowlders on the surface and within the type, in the color of the subsoil, in topography, and in having a much less compact structure. In places it appears to be underlain by residual granitic material, and there is some residual material mixed with it. The boundaries between the loam and silt loam are very arbitrarily drawn.

The Palouse loam occurs in Ts. 25 and 26 N., R. 40 E., where it covers an area of about 30 square miles near the Lincoln County line. The only associated type is the Cheney silt loam, which occurs on the two prominent ridges or elevations. The loam has for the most part an erosional topography, but there are practically none of the steep north slopes typical of portions of the silt loam, and none of the type is too steep for cultivation. It has a sloping to undulating and rolling surface, and lies 50 to 150 feet above the extensive basaltic plateau to the west and south. All of the type is well drained, drainage courses extending to practically all portions. Only the larger ones carry water, and even they are nearly dry in the summer months. The normally light precipitation is nearly always absorbed by the soil, and there is little or no run-off. The present drainage system is the result of earlier and more humid climatic conditions.

Practically all this type is under cultivation in one big wheat field and summer fallow. The native vegetation consisted almost wholly of bunch grass, with some sagebrush, and in the early days it supplied considerable grazing. Favorable topography, productive-

ness, and prairie character favored the early development of the type. It is regarded as a very desirable soil for wheat farming. Wheat hay forms the greater part of the coarse feed for stock. Both winter and spring varieties of wheat are grown. Yields range from 10 to 45 bushels or more per acre. Oats are a very minor crop.

This type has not been in cultivation for as many years as the Palouse silt loam to the southeast. Winter wheat has always led in acreage with about an equal area in fallow. The farms are fairly large. For spring wheat the fields are plowed in the fall. No rotation of crops is practiced.

The Palouse loam is not remote from transportaion facilities, as the Northern Pacific Railroad (Washington Central Branch) traverses the southern part of its area. All of it is improved, and land values are fairly uniform. Sales are reported at $75 to $100 an acre.

Deeper plowing would give good results on this soil. Spring wheat should be grown as much as practicable, in order to eliminate the season of fallow. Some system of crop rotation should be adopted to conserve the soil productiveness.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the Palouse loam:

Mechanical analyses of Palouse loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551332	Soil	0.4	1.1	1.0	12.6	27.5	46.7	10.4
551333	Subsoil	.8	2.5	3.0	24.0	25.50	35.6	8.8

PALOUSE SILT LOAM.[3]

The Palouse silt loam consists of about 10 inches of dark grayish brown, friable silt loam underlain by yellowish-brown to brown, heavy silt loam to silty clay loam which extends below a depth of

[3] The dark-colored upland soils in the central and western part of Spokane County were placed in the Palouse series, differentiating them by texture only, notwithstanding the fact that there is known to be a considerable range in soil characteristics included. In the extreme western and southwestern part of the county the predominant soil is darker than farther east, the subsoil is more uniformly brown in color and free from the mottling due to poor subsoil drainage than farther east and the horizon of carbonate accumulation is widely present, though it often lies below the level of the 3-foot section. In the central and eastern parts of the county the zone of high carbonate content is not present at any depth, either in the subsoil or substratum. The subsoil is usually mottled, showing, even in strongly rolling areas, the influence of a high rainfall and the resulting imperfectly drained and oxidized subsoil. Field work in Kootenai County, Idaho, during the summer of 1919 has shown the presence along and near the State line, in the prairie southeast of Spokane, of such soil over considerable areas in both States. The Palouse fine sandy loam probably belongs with this variety of soil, though it has not been examined from that point of view. That the carbonate horizon is not present in either has been determined.

Such soils are not typical Palouse and were the area to be mapped anew they would not be included with this series. They are more nearly related, because of their lighter color, their mottled subsoils, and the absence of the stratum high in carbonate, to the Nez Perce soils in the Nez Perce-Lewis area, of Idaho, but differ from the latter in the absence of a gray subsurface horizon.

The central and eastern part of Spokane County lies in a region of heavier rainfall than the western part and the differences in soil characteristics mentioned above are the results of this difference in moisture. From the agricultural point of view the difference is not wide, but the larger amount of soil moisture probably has some effect in crop growing.

The Palouse loam has the characteristics of the typical Palouse series.

3 feet, forming the substratum. The type contains practically no material coarser than fine sand. Cuts along railways and highways to a depth of several feet indicate the unstratified character of the underlying material. The surface soil is high in organic matter and when wet has an almost black color. A very compact or rather tough structure is typical of the subsoil. The type is noncalcareous within the 3-foot section in typical areas. The soil mantle is typically underlain at depths ranging from a few feet to 50 feet or more by basalt, but it overlaps on areas of granitic and schistose rocks. The latter do not outcrop, but along some of the valleys of the larger drainage courses here and there narrow rims of basalt occur. In areas underlain by granites and schists the subsoil is subject to quite wide variation, and is either modified in character by, or derived mainly from, the weathering in place of the underlying rocks. In these areas it grades on the one hand toward the heavier and more thoroughly weathered material, a stiff silty clay loam, and on the other toward partially decomposed, fragmentary granitic rock. In the latter case it has a grayish to mottled gray and yellow color. Good exposures, showing the variable character of the subsoil of these areas, occur along the line of the Inland Empire Electric Railroad between Moran and Sharon. Where exposed in cuts the compact subsoil material checks into cubes on drying out. The soil may include a small amount of old weathered lake-laid material on the lowest slopes.

A conspicuous variation in the type consists of brown patches occupying prominent places on the hills. They are usually 100 feet or less in diameter, and seldom exceed an acre or two in extent. They are caused by the exposure of the subsoil material largely as a result of the downward creep of the surface soil through repeated cultivation. The soil in these spots is deficient in organic matter, difficult to handle, and in some seasons quite unproductive.

Another variable feature, as shown in cuts, is the presence in places of lenticular masses, 6 to 8 inches thick, of gray material at depths between 3 and 6 feet below the surface. These consist of portions of the substratum highly impregnated with accumulations of lime leached from the overlying material. (Pl. III, fig. 1.) They are seldom seen in the eastern part of the areas, but they increase toward the west and are also found closer to the surface, until in the extreme western part occasional small gray spots on hillsides are due to their exposure. Another variation in the type which also seems more apparent toward the west is the presence of a subsurface layer or upper subsoil of brown color and friable structure.

The northern limits of the Palouse silt loam, which is an extensive soil in the southeastern part of the State, are reached in this county. It is the predominant soil and in some localities almost the only

type, as in Ts. 21 and 22 N., Rs. 43, 44, and 45 E., and in Ts. 21 N., R. 42 E. In other townships in the southern part of the county it covers areas ranging from 25 acres to several square miles in extent. Areas underlain by granitic rocks occur in T. 24 N., Rs. 43 and 44 E.; to the northeast, west, and southwest of Mica; north of Freeman; and on each side of the Inland Electric Railroad line between Moran and Sharon. An area of considerable size occurs in the vicinity of Cheney. Other areas are found in the extreme southwestern part of the county.

In its typical development the Palouse silt loam has the topography characteristic of large areas of rolling "wheat country" in southeastern Washington. In general the hills rise to a fairly even height, but there are occasional conspicuous elevations due to the presence of outlying areas of rocks other than basalt. The greater part of the type lies between elevations of 2,400 to 2,700 feet, but some of it lies even higher on the slopes of the above-mentioned hills. The individual hills have an irregular but rounded or smooth outline, with slopes ranging from gentle to steep, and only a few small areas are too steep for the use of modern farm machinery. (Pl. III, fig. 2.) Quite frequently the north slopes are the steepest, and this fact is commonly ascribed to wind action. In this county by far the greater part of the type has an erosional topography, with an irregular dendritic drainage system which reaches to all parts. The isolated areas in the southwestern part of the county are conspicuous in that they rise quite abruptly from the basaltic plain, with crests 100 to 300 feet above the plain level.

The areas of Palouse silt loam underlain by granite rocks for the most part occupy east and south slopes of hills which have forested soils of the Moscow series on the north and west slopes. On some hills it extends over on the north slope for a short distance. The slopes are ramified by numerous drainage ways which occupy small, shallow and widely spreading V-shaped valleys and which fork repeatedly, spreading to all portions of the areas.

The drainage of the type is adequate, but as the precipitation is light and never torrential there is no destructive erosion. Very few of the drainage courses shown on the soil map carry water at any period except after the sudden thawing of snow. Even the main streams are seldom perennial. Water for farm use, however, is obtained at comparatively shallow depths.

The Palouse silt loam is conspicuous for its remarkable uniformity, in contrast to the varied and complex soil conditions in the remainder of the county. It covers a large part of Whitman County and an undetermined portion of the counties to the west and south. It is also a predominant type in Latah, Nez Perce, and Lewis Counties, Idaho.[4]

[4] Reports of soil surveys of Latah, Nez Perce, and Lewis counties, Idaho, by the Bureau of Soils.

It is the chief wheat-producing type of this county, as well as of the whole Palouse region. The native vegetation consisted of a rank growth of bunch grass, with scattering rose bushes, buckbrush, and other shrubs.

The bunch grass early attracted the attention of stockmen, who later gave way to the wheat farmers, and at present all of the type is in cultivation. It is favorably located with respect to transportation and market facilities, and is regarded as highly productive and desirable for both general and special crops. It holds moisture fairly well, and crops suffer from drought only during exceptionally long dry spells.

Three types of farming are carried on, winter or spring wheat alternating with summer fallow, spring wheat alternating with peas grown for seed, and orcharding. The first-named type is most generally practiced. The second prevails in a section near Fairfield, and the last in several well-defined localities northeast of Fairfield, east and southwest of Meadow Lake, and near Hillby, Willow Springs, Kiesling, and Sharon. Wheat has been the only crop grown on many farms since the land was first put in cultivation, and the one-crop system has resulted in combination until the average wheat farm, owned or leased, now comprises upward of 1 square mile. As a rule a greater acreage is devoted to winter than to spring wheat. The growing of peas for seed under contract with eastern seed houses is a new industry. The pea crop is followed by spring wheat. Oats and barley are produced to some extent in the eastern areas of the type, where the precipitation is slightly greater. Potatoes are grown for market on a few farms. There were a number of commercial orchards planted with a view to selling them in small tracts. The trees are young and apparently in thriving condition. Minor crops include timothy and clover for hay, grains cut green for hay, alfalfa, and small fruits.

Wheat ordinarily yields 10 to 35 bushels per acre, but 50 bushels has been reported in some cases. Oats range from 30 to 70 bushels per acre. Peas yield 30 to 40 bushels in favorable years. During the present season (1917) the apple crop was reduced by drought, and the fruit did not color to equal that of the irrigated tracts.

Land in summer fallow is cultivated during the summer months sufficiently to keep down the weeds and preserve a soil mulch. Fall plowing is done when there is enough precipitation to permit it. Winter wheat is sowed in the fall as soon as there is sufficient moisture to germinate the seed, and spring wheat is sowed as early as conditions permit in the spring. The land is plowed for peas, but is usually disked for the following wheat crop. Orchards are given clean cultivation, and are not irrigated. Tractors are used on only a few farms.

In the grain-farming section areas of the Palouse silt loam find a ready sale at $75 to $150 an acre, depending upon the location and improvements. Orchard tracts are valued at $300 to $500 an acre.

The greatest need of this type is the adoption of some systematic rotation of crops in order to maintain its productiveness and avoid the loss of one cropping season, as is necessary in fallowing. The alternation of spring wheat and peas promises to be successful. A rotation well recommended but not widely followed consists of peas, spring wheat, barley, and clover. Deeper plowing would prove beneficial in many cases.

Palouse silt loam, shallow phase.—The Palouse silt loam, shallow phase, consists of about 6 inches of brown to dark-brown loam to silt loam, resting on the granitic bedrock, of which numerous outcrops occur. The subsoil, which is found only in pockets between the outcrops and areas of shallow surface soil, is a brown loam to sandy loam to bedrock. It is probable that the fine-earth mantle seldom exceeds 3 feet in depth. A few bowlders are scattered over the surface.

The phase occurs on the south side of the Spokane Valley in association with areas of the typical soil. It has a rolling to hilly topography and is excessively drained. None of it is under cultivation, but native prairie grasses afford some pasturage.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the typical Palouse silt loam:

Mechanical analyses of Palouse silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551338	Soil	0.1	0.6	0.3	2.5	15.8	62.3	18.0
551339	Subsoil	.0	.2	.1	1.4	19.0	62.6	16.2

HELMER SILT LOAM.

The surface soil of the Helmer silt loam is a light yellowish-brown to pale-yellow, friable silt loam, 10 to 12 inches deep. It gives way to a stratum of gray or ash-colored silt loam averaging 6 inches in thickness. The subsoil proper is a yellowish-brown, very compact, heavy silt loam or silty clay loam extending with little change to bedrock, which lies 25 to 100 feet or more below the surface. In places the type has a few bowlders on the surface, and other rock fragments are found upon close examination of deep cuts along highways and railroads. The surface soil is rather low in organic matter, and assumes a grayish color upon drying out.

This is the predominant soil in T. 23 N., Rs. 44 and 45 E. Small areas also occur in the townships to the north and south. The type

lies from 2,400 to 2,600 feet above sea level, occupying a more or less irregular series of hills whose crests have a fairly common level. Much of it has a typical erosional topography, with a widely branching drainage system which reaches to all parts of the type. The slopes range from gentle to moderately steep, and all of the type may be farmed with modern implements. The drainage courses seldom carry water, all the precipitiation being absorbed.

The Helmer silt loam is a locally important soil. Originally it was heavily timbered with pine, fir, tamarack, and underbrush, but nearly all the virgin forest has been removed, and approximately 90 per cent of the type is in cultivation. It has not been farmed as long as the Palouse silt loam, but development has progressed so rapidly that almost as high a percentage is under cultivation. It lies within 20 to 30 miles of Spokane and near transportation facilities. The soil is easily cultivated, holds moisture fairly well, and is regarded as desirable for general farming.

Wheat, the leading crop, gives yields of 15 to 30 bushels per acre. The acreage in winter wheat exceeds that in spring varieties. Oats and barley are grown to some extent, and potatoes and other vegetables are produced for home use. Tame grasses are grown for hay, in addition to which grains are often cut green. The type is handled in much the same way as the Palouse silt loam.

Land values range from $50 to upward of $100 an acre, according to the improvements and location.

The greatest need of this type is the adoption of systematic rotations which will increase its productiveness. The rotation should include green crops, preferably legumes, to be turned under for the purpose of supplying needed organic matter.

The table below gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Helmer silt loam:

Mechanical analyses of Helmer silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551340	Soil	0.0	0.4	0.4	3.7	15.0	64.7	15.4
551341	Subsoil	.2	.4	.2	3.9	19.0	67.0	8.4
551341x	Lower subsoil	.1	.5	.3	1.8	14.5	55.7	26.7

MARBLE COARSE SAND.

The Marble coarse sand consists of a light grayish brown, loose, coarse sand with little or no variations in color, texture, or structure to a depth of several feet. In sampling, an arbitrary depth of 6 inches was taken to represent the surface soil. In cuts the dry surface of the

subsoil material appears rather gray, but this difference is not apparent on a fresh surface. The type is free from gravel and stones.

The largest area of Marble coarse sand lies 2 to 3 miles northeast of Deepcreek station. Other areas are found about 2 miles northeast of Mead. The type is associated with the sand of the same series, and with the coarse-textured types of the Springdale series.

The surface has the natural choppy and hummocky features typical of wind-blown sands. The porous structure permits the rapid absorption of moisture and its movement downward beyond the reach of vegetation.

The Marble coarse sand is of small extent and unimportant. None of it is used for annual crops. It supports a scattered growth of yellow pine together with some sand-loving shrubs and bunch grass. Under present conditions it is regarded as of little value for farming. There is no demand for land of this character. Its sale value depends on the character of the forest growth and on the proportion of good farming land associated with it.

MARBLE SAND.

The Marble sand has a surface soil of grayish to light-brown incoherent sand and a subsoil of light-yellowish or brownish-gray, porous sand extending to a depth of 3 feet or more. A rather arbitrary depth of 6 inches was assumed to represent the surface soil, as there is very little change in color, texture, or structure throughout the 3-foot section. Light and dark colored sand grains in about equal proportion make up the soil mass. The soil between the ridges and knolls has a slightly higher silt content than that on the ridges. The type is free from gravel and bowlders, and is underlain by porous material to a depth of many feet.

The Marble sand is fairly well developed in the vicinity of Mead, in T. 26 N., R. 43 E. Another area of considerable size is located southeast and east of Denison, in T. 28 N., R. 43 E. Several small areas occur in association with the sandy terrace soils in the northern part of the county.

The type has a characteristic wind-blown topography, consisting of a promiscuous arrangement of ridges and knolls with intervening depressions. The absorption of all surface moisture takes place quickly, and the excess readily finds its way to lower depths.

Approximately 5 square miles of this type are mapped in Spokane County, and less than 100 acres are cleared and in cultivation. The remainder has a scattered growth of fairly large yellow pine, with a thick growth of sand-loving shrubs in places. Bunch grass grows where the forest is not too dense, and supplies some pasturage. The native vegetation prevents the shifting of the soil by the winds.

The entire area of this type in cultivation is included within an orchard tract south of Denison. No other crops are grown. The trees have a good color, have made a satisfactory growth, and produce fair yields of fruit. The surface soil was subject to drifting by the wind when the land was first cleared, but it is now sufficiently protected by the orchard trees and interplanted crops. Under irrigation the type retains sufficient moisture for orchard and farm crops, but it is best adapted to intensive farming. The low organic content should be increased by plowing under manure and green crops, especially the legumes. This will aid the soil in retaining moisture and tend to prevent the soil from blowing.

Undeveloped land of this character is not in demand for farming purposes. Its sale value is based upon the forest stand and the value of the associated types.

CALDWELL SILTY CLAY LOAM.

The Caldwell silty clay loam consists of 12 to 15 inches of compact, dark-gray silty clay loam underlain by medium-gray to drab, compact silty clay loam to silty clay which is frequently mottled with light gray, especially in the lower portion of the 3-foot section. Material similar to the lower subsoil continues to the underlying basaltic rock. When wet the soil is black and sticky, but in a dry condition it is dark gray, and compact and hard. Exposures of the soil profile in dry weather show numerous cracks and checks, resembling an adobe structure. In places where the soil approaches a silt loam in texture, the color is more nearly dark brown. A few areas are included which represent local recent alluvial-fan material deposited over the bottom land proper.

The type occurs in association with the Palouse silt loam in the southeastern one-fourth of the county, mainly along Latah Creek and its larger tributaries. As a rule the channels are well defined but in places the streams follow rather poorly defined, meandering courses. Although seldom subject to overflow, much of the type is poorly drained, especially in the spring, when water from the melting snow on the surrounding hills finds its way to this soil. Its level character and the slight fall of the streams cause it to drain slowly.

The Caldwell silty clay loam is of small extent, but all of it is cultivated, in conjunction with the surrounding Palouse silt loam. The type is natural prairie, and originally supported a growth of native grasses. Cultivation is sometimes delayed by the wet condition of the soil in the spring. The best drained areas are quite frequently sowed to oats. Some of the type is used for pasturage, while part supports a growth of tame grasses which are cut for hay.

Mechanical analyses of samples of the soil and subsoil of the Caldwell silty clay loam gave the following results:

Mechanical analyses of Caldwell silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
571398	Soil	0.5	0.7	0.4	5.8	18.0	56.1	17.9
551399	Subsoil	.0	.8	.8	7.4	19.5	46.3	24.8

PEONE SILT LOAM.

The Peone silt loam consists of a light-gray to nearly white, compact silt loam underlain at 6 inches by a light-gray or nearly white silt loam which extends to a depth of 3 feet or more. The soil depth is rather arbitrary, as there is little change in the material downward from the surface except for slight mottling in the lower part of the 3-foot section. Pockets and lenses of fine sand occur in the lower portion of the subsoil and in the substratum.

This type occurs along Deadman, Peone, and Deep Creeks, in Ts. 26 and 27 N., Rs. 43 and 44 E. Small areas occur north of Rockford. The surface of the type is level. The streams follow rather definite courses, though they are only slightly entrenched. Drainage is usually slow, and in addition short periods of overflow occur in the early spring.

The Peone silt loam is the least extensive of the alluvial soils, and less than 50 per cent of it is cultivated. The remainder is sparsely forested. Wheat, oats, and potatoes, the leading crops, give medium yields in favorable seasons.

The sale value of this land depends largely upon that of the adjoining types, as all the farms are located partly on other soils.

The low organic content of the Peone silt loam should be increased by turning under green crops. Some areas would be benefited by artificial drainage.

The results of mechanical analyses of samples of the soil and subsoil of the Peone silt loam are given in the following table:

Mechanical analyses of Peone silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
5513100	Soil	0.0	0.3	0.2	3.7	11.8	66.5	17.1
5513101	Subsoil	.0	.5	.5	3.6	9.7	67.1	18.4

COLVILLE FINE SANDY LOAM, DARK-SUBSOIL PHASE.

In this county the typical Colville fine sandy loam does not occur, and the type is represented only by the dark-subsoil phase. This consists of a medium to dark gray fine sandy loam, sometimes

becoming nearly black, underlain at 6 to 8 inches by a gray to dark-gray loam to fine sandy loam which extends to a depth of 3 feet or more. The underlying deeper substratum is usually lighter gray in color and coarser in texture. The soil is rather high in organic matter, and has a friable structure. Mica flakes are usually abundant in both surface soil and subsoil.

There is a fairly wide variation in this soil, as the sediments are derived from formations of different kinds and have been deposited by streams of varying gradient. Along the Little Spokane River the soil has a finer texture than along shorter and more swiftly flowing streams, where in places it becomes as light as a sandy loam or coarse sandy loam. In some cases there is a moderately heavy upper subsoil stratum underlain by a bed of grayish sands. Freshly exposed subsoil material sometimes has a slight greenish color, which disappears upon drying. The fairly wide variation in the phase is due to its inclusion of all the dark-colored, forested, alluvial soils, on account of their relatively small extent and similar agricultural value.

This phase is confined to the bottoms of streams whose valleys are mainly within soils of granitic derivation, and is found almost entirely in the northern half of the county. It is the most extensive of the recent-alluvial soils. The largest areas occur along Little Spokane River and some of its tributaries. Minor areas are mapped along Dragoon, California, and Latah Creeks. The areas are in many places narrow, though of considerable length.

The surface is fairly smooth except for irregularities due to changes in the stream channels from time to time. There is a slight slope in the direction of the stream flow. As a rule the streams follow shallow and frequently meandering channels. Floods are infrequent, on account of the forested character of the greater part of the stream basins, but portions of the areas are subject to short periods of overflow. The internal drainage is slow.

Nearly all of the original forest has been removed, and approximately 75 per cent of the phase is used for crops. Small trees and brush cover the remainder. The adaptation of the soil to hay crops makes it of comparatively high value in many sections where it occurs, as the associated soils are not well adapted to forage crops. Tame grasses, mainly timothy, are cut for hay and yield one ton or more per acre. Oats, which are practically the only grain crop, give medium yields. As the phase occupies the lowest positions in the localities in which it occurs, other crops are subject to damage by frost. A considerable acreage is used for pasture, and the hay fields also afford considerable pasturage after the hay is cut. This soil forms an important part of several large dairy farms in the Little Spokane Valley.

Land valuations range widely with differences in location, in the improvements, and in the nature of the associated soils. The range is from $25 to upward of $200 an acre. No sales are reported at the higher figures, but a few farms are held at such prices.

Improved drainage would benefit this soil, and may be accomplished by straightening and deepening the stream channels in some cases and by constructing ditches to catch the spring and seepage water on the upland side of certain areas. Liming would also be found beneficial.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the Colville fine sandy loam, dark-subsoil phase:

Mechanical analyses of Colville fine sandy loam, dark-subsoil phase.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551396	Soil	0.0	0.9	2.0	38.6	27.1	24.6	6.3
551397	Subsoil	.0	.8	2.8	49.4	25.0	16.7	4.9

COLVILLE SILT LOAM.

The surface soil of the Colville silt loam is a dark-gray to black silt loam, extending to a depth of 6 to 10 inches. The subsoil in its typical development is a light-gray, compact silty clay loam or clay loam which extends to a depth of 3 feet or more. Light colored, heavy material continues to a depth below 6 feet. The soil has a fairly friable structure and is high in organic matter. It is free from rock outcrop and stones. The subsoil is always more compact and in most cases heavier than the surface soil.

In some places the surface soil is especially shallow and heavier than a silt loam, and such areas would be mapped as a silty clay loam if of sufficient extent. Where the subsoil material has been mixed with the soil by plowing, the soil has a color lighter than typical.

The Colville silt loam, though inextensive, is quite widely distributed throughout the glaciated uplands and old valley filling areas to the north of the Spokane River. It occupies depressed or basin-like positions along stream courses where the drainage has been so restricted at some time that the bottom-land soil has the characteristics of lacustrine rather than of alluvial deposits. The type naturally is very slowly drained, and artificial drainage has been established over the greater part of its area. This removes the excess water but does not always insure sufficient drainage to permit the early planting of crops.

This is an important hay and pasture soil, and nearly all of it is used for some agricultural purpose. Some of the type was originally

forested, while other areas were probably treeless as a result of too much moisture. Hay and grain are the leading crops, and yields range from medium to good, depending upon the season and the thoroughness of the artificial drainage. Crops are seldom injured by drought. As a rule the type is kept in grass the greater part of the time. When broken it is sowed to grain and seeded to grass as soon as possible. It is pastured excessively.

Areas of this soil are valued, along with the adjoining types, at $50 to $100 an acre.

Colville silt loam, dark-subsoil phase.—The surface of the Colville silt loam, dark-subsoil phase, consists of about 10 inches of very dark gray to black, fine-textured loam or silt loam, exceedingly high in organic matter. The subsoil is a dark-gray to nearly black silt loam to loam extending to a depth of 3 feet or more. Light-gray material usually appears in the last few inches of the 3-foot section and continues to form the substratum. The phase is usually free from outcrops and fragments of rock, and the underlying basalt seldom comes within the 3-foot section. Both soil and subsoil have a friable structure under moist conditions. The subsoil material becomes much lighter in color upon drying out. It is remarkably light in weight.

As mapped the phase includes small areas of Link silt loam and of Muck and Peat. In places slightly elevated areas of Scabland or of rock outcrops project a few feet above the surface.

This phase is confined to the physiographic division known as the Columbia Plain, which is in the Intermountain soil region, while the typical Colville silt loam occurs in the glaciated uplands and terraces.

The Colville silt loam, dark-subsoil phase, occurs in the southwestern fourth of the county in association with Scabland and to a lesser extent with the soils of the Hesseltine, Cheney, and Link series. It is most extensive to the west and southwest of Cheney. The phase occupies basinlike depressions in the basaltic rock, or situations along very poorly defined drainage courses. It has a flat surface 2 to 10 feet below the adjacent soils. The natural drainage channels are usually inconspicuous, and where artificial drainage has not been provided, the areas are covered with water for at least a part of the year. The surface water is removed mainly by evaporation.

This is a fairly extensive and widely distributed soil in the section of the county where it is found. The areas are for the most part rather small, and usually elongated in a north-south or northeast-southwest direction. In some cases they are very narrow strips in old drainage channels, but there is usually a more or less well-defined chain of areas, separated by Scabland or by glacial-till soils.

This is an important soil in the southwestern part of the county, where it has made possible the development of the dairy and stock-

raising industries. The surrounding country is forested and affords protection from the winds. Only the smaller few undrained areas remain in the native vegetation. The wet areas usually have a growth of cat-tail and rushes; others are in wild grasses. Probably 90 per cent of the phase either has been or is now in cultivation. In many cases it comprises the only part of the farm that can be cultivated successfully, and an area of the type generally marks the location of one or more farms.

Hay is the leading crop. Tame grasses, chiefly timothy, are cut, giving yields of 1 ton and upwards per acre. Grains, chiefly oats, are also grown quite extensively, and give good yields in favorable years. Pasturage is an important use of this soil. Potatoes are grown on the best drained areas.

This soil is kept in grass as much as possible. On some farms it is broken occasionally for the growing of grain crops, while other farms have associated soils on which grain may be grown. The type is usually plowed in the fall and sowed to oats and seeded to grass as early as conditions permit in the spring. It is heavily grazed either throughout the season or after the hay is cut in the summer. Stable manure is usually applied before plowing.

Farms on this soil sell for $50 to upwards of $100 an acre, according to the proportion of it in the farm. It is very seldom that farms are raised in value by the inclusion of other types.

More efficient artificial drainage, by means of a larger number of deeper ditches, is the greatest need of this phase. Draining can best be accomplished by cooperation among the owners, as one area has to drain through another. Liming the soil should prove beneficial.

LINK SILT LOAM.

The Link silt loam consists of a light-gray silt loam extending to a depth of about 6 inches and underlain by a light-gray to nearly white silt loam or loam which extends to a depth of 3 feet or more. Light-colored material continues to the underlying basaltic bedrock, which is found at 3 to 6 feet or more below the surface. The type is free from rock outcrop, stones, and gravel. The soil in the surface few inches is loose and fluffy when dry, and the whole type has a moderately loose structure.

This soil is of such small extent that its variations are not important. In places it carries noticeable quantities of fine sand. In some areas the immediate surface layer is slightly darker than typical, while in others it is sometimes nearly white. The basaltic bedrock seldom comes within the 3-foot section, but is usually encountered above a depth of 6 feet.

The Colville silt loam, dark-subsoil phase, and Scabland are closely associated with this type, and a few areas, too small to show on the

soil map, are included with each. The type occurs in the southwestern one-fourth of the county.

The surface is level, and usually slightly depressed, the areas occupying either all or portions of basinlike situations. The elevation of the type ranges from 2,300 to 2,400 feet above sea level. All the drainage is internal, and drainage is adequate except in wet seasons and where artificial drainage has not been established.

This is one of the most inextensive and unimportant soil types in the county. Part of it is cultivated to grain and potatoes, which give light and uncertain yields, and the remainder has a sparse cover of native grasses and is used for pasturage. Rye grass, a rank-growing bunch grass, is a common growth in places, though it is seldom found on any other type in the county. The type in places appears to contain a small percentage of alkali. Land values depend upon those of the adjoining soils.

Mechanical analyses of samples of the soil and subsoil of the Link silt loam give the following results:

Mechanical analyses of Link silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
551390	Soil	4.0	7.6	1.8	6.5	16.5	56.2	6.5
551391	Subsoil	6.5	10.6	1.9	6.4	19.2	50.6	4.6

MUCK AND PEAT.

Soil material derived largely from the decomposition of organic accumulations is mapped as Muck and Peat. Each of the included types is well developed in this county, but the latter is much more extensive. In many instances one soil grades into the other so that separation is necessarily arbitrary, and on account of the close association of the two soils and the slight agricultural difference between them in this county they are not shown separately on the map. Muck is usually black in color, in contrast to the prevailing brown color of the Peat. The former is quite thoroughly decomposed and has an admixture of mineral matter, while the latter shows a fibrous structure and contains little or no mineral matter. The fibrous material of the Peat is invariably fine textured. None of the areas have been forested, and the original fibrous structure has been partially destroyed by cultivation.

The organic deposits range in depth from a few inches to several feet, being deepest in the center of the areas and thinning out near the margins. By far the greater part of the type exceeds 3 feet in depth. The shallowest areas are found in the Scabland section of the county, where the type grades into the Colville silt loam, dark-

subsoil phase, or the Link silt loam, or is underlain by grayish material to the subsoil of the latter type.

The largest area of Muck and Peat occupies Saltese Marsh, about 3 miles southeast of Greenacres. Another is mapped at both the head and foot of Newman Lake, in T. 26 N., R. 45 E. An area is mapped south of Marshall, and several occur in the "Beaver Bottoms" along the upper part of Bear Creek. A number of small bodies are found elsewhere, especially in the Scabland section east, southeast, and south of Cheney, and in the valley of the Little Spokane River.

The surface is flat, and lower than that of the surrounding soils. There is little or no natural drainage, but more or less complete artificial drainage has been established in practically all the areas, and the water table, which was formerly above the surface during part of the year, now is sufficiently lowered to permit of farming operations during the greater part of the year. The type lies at elevations ranging from 1,600 to 2,200 feet above sea level.

The areas of Muck and Peat, though relatively inextensive, are of considerable importance locally, on account of their adaptation to the production of hay. They originally supported a growth of native grasses and other water-loving vegetation, without any trees. Approximately 95 per cent of the land is now in cultivation to tame grasses and oats, the remainder being used for pasturage. Hay gives good yields of fair quality, and after the crop is cut the grasses afford abundant pasturage for the remainder of the season. Oats are a more uncertain crop, yields varying from poor to good. In some seasons the crop grows so rank that it lodges and fails to fill. In addition, seeding is frequently delayed by an excess of water in the soil. The areas of Muck and Peat are adapted to other crops than hay and oats, but the danger of loss by frosts prevents to a large extent their further use. In the Scabland section, dairy farming is carried on in connection with areas of Muck and Peat.

Sales of this land have been scarce in the last few years. It is held at prices ranging from $25 to $100 or more an acre.

Many farmers prefer fall plowing for these soils, as it puts them in better condition and enables earlier planting of crops. Some of the areas would be improved by deeper plowing. The improvement of the artificial-drainage systems would increase the crop production.

SCABLAND.

Scabland includes stony areas which are not necessarily rough in topography, but which have almost no soil mantle above the bedrock. Outcrops of basalt and areas with only an inch or two of partially decomposed rock occupy over one-half the total extent of the type. The outcrops are, for the most part, flat, rising only slightly above the general level, and in some places the exposed rock is lower than the surface of the soil. In some areas steep or perpen-

dicular cliffs of basalt occur. Promiscuously intermingled with the outcrops, which are the most conspicuous features, are low, rounded mounds of soil, thin layers of soil over the surface of the rocks, or pockets of soil between the outcrops. The fine earth is of mixed origin, either glacial, stream-laid, residual, or loessial, and frequently due to a combination of two or more of these agencies. The loose stones are mainly basaltic and angular or subangular. The glacial erratics are mainly granite. They range from small to large, and are usually fairly well rounded. In many places they are inconspicuous, as they have taken on a "desert polish," giving them the appearance of basaltic fragments. Scabland differs from Rough stony land in being less rough and in being confined to basaltic-rock areas. The application of this term to land of this kind is practically universal throughout the Northwest.

Scabland may occur anywhere in the county below an elevation of 2,500 feet except where the basaltic rock is concealed by stream, lake, or glacial deposits. It is the predominating soil in Ts. 21 and 22 N., Rs. 40 and 41 E., and in Ts. 22 and 23 N., R. 42 E. It is also extensively developed in T. 23 N., R. 41 E.; T. 24 N., Rs. 40, 41, and 42 E.; T. 25 N., Rs. 42 and 43 E.; and in T. 26 N., R. 41 E. Numerous areas occur in the adjoining townships. Scabland is associated in occurrence principally with the Hesseltine, Cheney, and Colville soils.

This type occupies a plainlike section of the county whose local irregularities are due for the most part to unevenness in the rock surface. Basinlike areas are common, many of them too small to map. In places the type has a terraced topography, conforming to the surface of the underlying rock. Many poorly drained areas occur within the limits of the type, but the typical Scabland usually is excessively drained. There are few well-defined drainage courses, but springs and lakes are found in places.

This is one of the most extensive types of soil in the county, but it has a low agricultural value. The only cultivated portion consists of fields ranging from a fraction of an acre to upward of 5 acres in extent. The type provides some pasturage during part of the year. The greater part of it supports a very scattered growth of pine, with some undergrowth. The remainder is treeless, and may at one time have supported some sagebrush. The best use of this land is for pasture and timber crops. Even under irrigation and intensive methods of cultivation very little of it could be successfully farmed. Its selling value depends upon that of the soil types associated with it.

ROUGH BROKEN LAND.

Rough broken land includes steep or rough areas practically free from rock outcrop and stones. Steep or eroded terrace fronts make up the greater part of the type. The soil consists of loose sand,

gravel, and cobbles lying on slope which often exceeds 45 degrees. A few steep areas of glacial till are included with the Rough broken land. Some of the areas lie below the rim or cap of basaltic rock on steep slopes that border many of the plateau or mesalike areas northeast of Spokane.

Rough broken land is best developed in the valleys of the Spokane River (below Spokane) and the Little Spokane River. It also occurs quite extensively in the canyonlike valleys of Latah (or Hangman) Creek, Coulée Creek, and Deep Creek, where steep slopes are covered with unconsolidated sediments. Several areas are found in the vicinity of Green Bluff School and near Pleasant Prairie, northeast of Spokane.

The type is excessively drained. It supports a scattered forest, with a thick growth of brush in places and, where the brush is not thick, a carpet of native grasses. The land is nonarable, and can best be used for pasturage and for timber crops. Its sale value is determined by that of the adjacent types.

ROUGH STONY LAND.

Rough stony land comprises areas so rough and stony that they can not be used for ordinary farming purposes. As mapped in this county it includes a large amount of rock outcrop. Fine-earth material occurs in pockets here and there, and may be of glacial, residual, or stream-laid origin. The stones are of various kinds, shapes, and sizes.

Rough stony land embraces the roughest and stoniest areas in the county. In places it has the appearance of a rim of cap rock, as it forms the steep escarpment bordering Fivemile and Pleasant Prairies and the mesalike area known as Green Bluff. It also occupies the canyonlike walls of some of the deeply entrenched stream courses, as along the middle course of Latah Creek. Either granite or basalt or both may form the bedrock.

The largest area of Rough stony land is mapped in the Latah and Rock Creek Valleys. Other fairly large areas occur in the Little Spokane Valley below Dartford, and smaller ones are numerous in the central and northern parts of the county.

Nearly all of this land has a sparse forest growth of pine, fir, and tamarack, with brush in places. It is not adapted to the production of farm crops, and affords very little pasturage. Its best use is in the production of timber crops. In places the present forest growth has some value. The land is sold in conjunction with the surrounding types.

ROUGH MOUNTAINOUS LAND.

Areas mapped as Rough mountainous land have such a rough topography, high elevation, and inaccessible position that agricultural development has not yet been attempted. A considerable

acreage has been taken up by settlers, and a fairly high percentage of the type has passed into private ownership. In this county the soil consists of undifferentiated material derived from the weathering of granitic rocks and belonging to the Moscow series of soils. The boundary drawn between this type and the lower lying Moscow very coarse sandy loam and loam is arbitrary and based largely upon the steepness of slope and the elevation. On the whole the soil mantle is shallow, though erosion at the present time is reduced to a minimum by the protecting mantle of vegetation. Rock outcrop is probably more common than on the lower slopes.

In places the Rough mountainous land includes areas of soil as desirable as those at the lower elevations, but the percentage of good farming land is small.

Approximately 97 square miles of Rough mountainous land are mapped in this county. It occurs in two large areas, occupying the highest elevations, the largest in Ts. 27 and 28 N., Rs. 45 and 46 E., including Mount Spokane, with an elevation of 5,808 feet, and Mount Carson; the other in T. 24 N., Rs. 45 and 46 E., including Mica Peak, with an elevation of 5,400 feet.

This type supports a cover of mixed fir, tamarack, and other trees. For the most part this is virgin forest. In some places the stand is valuable, but in others it is small and scattered, especially where destructive forest fires have raged. The forest cover on these divides doubtless has a marked influence in protecting and regulating the water supply of land at lower elevations.

Some of the Rough mountainous land probably lies at elevations too high for successful farming, even where other conditions are favorable. It frequently happens that where the soil has sufficient depth, it is too steep for cultivation, and where the topography is favorable the soil is too shallow. The greater part of the Rough mountainous land is best adapted to growing timber crops. No recent sales of land of this kind are reported.

IRRIGATION AND ALKALI.

The irrigated area in Spokane County comprises fairly extensive tracts of terrace lands in the Spokane Valley and in the vicinity of Deer Park and Denison.

In the Spokane Valley there are approximately 10,000 acres of irrigated land included within several well-defined districts, among which are Otis Orchards, East Farms, West Farms, and Pasadena Park on the north side of the Spokane River, and Vera, Greenacres, and Opportunity on the south side of the river. Gravity systems of distribution from Newman Lake and from sources in Idaho supply water for the districts north of the river. A ditch from Liberty Lake furnishes water for tracts in the vicinity of Greenacres. Water for

practically all of the remainder is pumped from wells by electricity or gasoline. The wells range from 50 to 100 feet deep, and are said to contain an abundance of water. No water is pumped from the Spokane River, as it flows in a trough 35 to 75 feet deep. All the water used for irrigation in the valley is of good quality. The districts are subdivided into tracts of 10 to 40 acres, the greater part of which are operated by owners. The irrigated area in the valley is not being appreciably extended at the present time, although there is a large acreage equally well adapted to this system of farming.

In the northern part of the county the irrigated area comprises approximately 5,000 acres in the vicinity of Deer Park and Denison, known as the Arcadia district. Water is supplied by gravity systems from Loon and Deer Lakes in Stevens County and from Dragoon Creek. The water is of good quality and is probably adequate for the present irrigated acreage. The district is subdivided into small tracts, part of which are operated by the owners. There are quite a number of other irrigated tracts, ranging in size from a few acres to 50 acres or more. These are for the most part on private farms. In addition there are a number of small irrigation projects that have fallen into disuse.

Apples are the leading product in the irrigated areas. There are a number of minor crops, including cherries, berries, potatoes, alfalfa, and vegetables.

There are at present no alkali problems in the irrigated area of the county. For the most part the irrigated tracts have excellent internal drainage, and they are supplied with water of good quality. No drainage systems have been installed. There are local areas on the basalt plain where slight accumulations of alkali occur, but these have little or no influence on the agriculture.

SUMMARY.

Spokane County lies in the extreme eastern part of the State of Washington. It is about 36 miles wide and 54 miles long, and contains 1,756 square miles, or 1,123,840 acres.

The county occupies portions of the Okanogan Highlands and the Great Plain of the Columbia. High rolling to hilly areas, or foothills, and hilly to mountainous areas are fairly extensive in the eastern and northeastern parts of the county. Rolling prairie occurs in the southeastern part, a basaltic plain mainly in the southwestern quarter, and glacial water-laid terrace areas mainly in the northern half. Approximately eight-tenths of the county lies between elevations 1,900 and 2,700 feet.

The Spokane-Columbia and the Palouse-Snake-Columbia River systems drain the county. The streams have fairly good gradients, and all except the largest are intermittent. Springs are of rather

common occurrence in the eastern and northern parts of the county. With the exception of a few basinlike areas the county is well drained.

The population of Spokane County in 1910 was 139,404, of which 22.8 per cent were classed as rural. Spokane, the county seat, has a population of 104,402.[1] It is the center of a fairly thickly settled section of the county. Hillyard is a railroad town just north of the city. Medical Lake, Cheney, Rockford, Deer Park, Fairfield, Latah, and Waverly are towns and shipping points of importance.

Three transcontinental railroad lines traverse the county, and with their numerous branches provide good passenger and freight transportation to all parts of the Northwest. All sections of the county have good railroad facilities. The public-road system is sufficient for present needs upon the elimination of some steep grades.

The summers are rather short, with long, moderately warm days. The winters are characterized by short days, moderate temperatures, and medium to heavy snowfall. The mean annual temperature as recorded is 47.8° F., and the mean annual precipitation 18.85 inches. The growing season is sufficiently long to mature most of the general farm crops.

Agriculture in Spokane County began less than 50 years ago. The prairie section was used as open range in the early days, and has since developed into the wheat-growing portion of the county. The census of 1880 reported approximately 7,000 acres in cultivation, which increased to 223,560 acres by 1909. In the latter year there were 3,947 farms in the county, covering 60.7 per cent of its area and averaging 172.9 acres in size. Fifty-three per cent of the land in farms was improved, or 32.3 per cent of the whole county.

Wheat is the leading crop, grown on 143,742 acres in 1909. The cereals represented 43 per cent of the total farm income in that year. Hay and forage crops totaled 18 per cent, vegetables 8 per cent, fruit 6 per cent, and all other crops 5 per cent. Approximately 20 per cent of the income was derived from live-stock sources. Dairying is the most important animal industry.

Several types of farming are carried on, including wheat growing, orcharding, trucking, dairying, and general farming. All are engaged in with more or less success. About 15,000 acres are farmed under irrigation.

The soils of the county are divided into eight groups. The residual soils are composed of the weathered products of the underlying rocks, mainly granitic. They have a rolling to hilly or mountainous topography and are well to excessively drained. The percentage of land in cultivation is rather small. These soils are classified into the Moscow, Huckleberry, and Underwood series.

The soils derived from ice-laid glacial drift are underlain by either granitic rocks or by basalt. Their surface is level to hilly. The soils

[1] See footnote on page 8.

of this group belong to the Loon, Waits, Hesseltine, Cheney, and Green Bluff series.

The soils derived from old water-laid material of the glacial lake and river terraces occupy extensive areas in the valleys of the Spokane and Little Spokane Rivers and a few of their tributaries, in the east-central, central, and northern parts of the county. Those soils underlain by loose, porous deposits are classed with the Springdale and Garrison series, and those underlain by fine-textured deposits with the Mission, Clayton, and Hunters series.

The loessial soils occur in the rolling plateau country in the southeastern part of the county. They are derived from a fairly thick mantle of fine wind-laid material which overlies basaltic rock. These soils belong to the Palouse and Helmer series.

The eolian soils consist of windblown sands, with the characteristic topography of wind-laid deposits. They are classed in the Marble series. The alluvial soils include the Marble series on the terraces and the Caldwell and Peone series on the first bottom. The recent-alluvial soils are of small extent.

The soils of the recent glacial-lake basins consist of recently accumulated or recently exposed sediments deposited in glacial lake basins and in stream valleys under conditions of obstructed or ponded drainage. They have a flat surface and are poorly drained. These soils are classed in the Colville and Link series.

Muck and Peat are derived mainly from accumulations of organic matter.

Scabland, Rough broken land, Rough stony land, and Rough mountainous land are largely nonarable.

The Moscow very coarse sandy loam and loam have brown friable soils and yellowish-brown to pale-yellow subsoils, grading toward gray in the lower part. Nearly all of the loam, heavy-subsoil phase, is in cultivation. The typical Moscow loam is second in importance, though of greater extent. The shallow phase of this type is the most extensive member of the series, but it covers high, hilly country and has little present agricultural value. The very coarse sandy loam is used for the production of forest crops and for pasture.

The Huckleberry gravelly loam is a brown soil with a pale-yellow or yellowish-brown subsoil. It is a forested, hilly soil, and none of it is farmed.

The Underwood loam is represented by only a shallow and reddish-colored variation, which has little or no agricultural value.

The Loon sandy loam and fine sandy loam have a light brownish-yellow soil with a pale-yellow or brownish-yellow, friable subsoil. Only a small part of these soils is under cultivation, general farm crops being grown.

Neither the Waits stony loam nor silt loam has much agricultural value. They are hilly, forested soils.

The Hesseltine stony loam and loam are brown to reddish brown, with brown and usually very stony subsoils. These soils are of little importance agriculturally.

The Cheney silt loam is similar to the Hesseltine soils except for its prairie condition. The soil is dark brown, with a yellowish subsoil. Nearly all of the type, with its shallow phase, is in cultivation to grain crops.

The Green Bluff loam is yellowish brown, with a yellowish, fine-textured subsoil. It is fairly free from stones and well drained, and is the largest strawberry-producing soil in the county.

The Springdale soils are light brown, with yellow to yellowish-brown upper subsoils and yellowish-gray lower subsoils. They are droughty, and best adapted to intensive farming under irrigation. A rather low percentage of their area is farmed without irrigation.

The Garrison series is the prairie equivalent of the Springdale. Nearly the entire area of the Garrison soils is in cultivation to grains, orchard fruits, and truck crops. Medium to good yields are obtained.

The Mission fine sandy loam and silt loam have light-brown to light grayish brown surface soils, light yellowish brown subsoils, and substrata of silts and clays. They are in an early stage of agricultural development.

The Clayton sandy loam, fine sandy loam, and very fine sandy loam have yellow to yellowish-brown soils and light-yellow to grayish-yellow subsoils. They are being developed agriculturally, and are used for general-farm crops.

The Hunters fine sandy loam and very fine sandy loam are the prairie equivalents of the Clayton soils. They have dark-brown surface soils and brown subsoils. Practically their whole area is used for grain growing and general farming.

The Palouse soils are dark brown, with brown to yellowish-brown, compact subsoils. They have a rolling surface, are well drained, and are practically all in cultivation.

The Helmer silt loam is a light-brown soil with a gray subsurface layer and a brown to yellowish-brown, compact subsoil. Nearly all of its area is in cultivation to grain and general farm crops, which give good yields.

The Marble coarse sand and sand have light-brown to brown soils and light-brown to yellowish-gray subsoils. They are forested and rather droughty, and are not used for farm crops.

The Caldwell silty clay loam is an alluvial soil occurring along streams in the rolling prairie country in the southeastern part of the county. It is rather poorly drained, but is farmed to grain.

The Peone silt loam is a forested type with a gray soil and gray subsoil. It is poorly drained, and of little agricultural importance.

The Colville soils are poorly drained, and used for hay and pasture.

The Link silt loam has a gray surface soil and a light-gray subsoil. It is used for pasture.

Muck and Peat are poorly drained, but they are of considerable importance locally for the production of hay.

There are approximately 10,000 acres of irrigated land in the Spokane Valley and 5,000 acres in the vicinity of Deer Park and Denison. Water is supplied chiefly by gravity systems, but some is supplied by pumping from wells. Apple orchards cover the greater part of the irrigated area. There have been no injurious accumulations of alkali in the irrigated districts.

○

[PUBLIC RESOLUTION No. 9.]

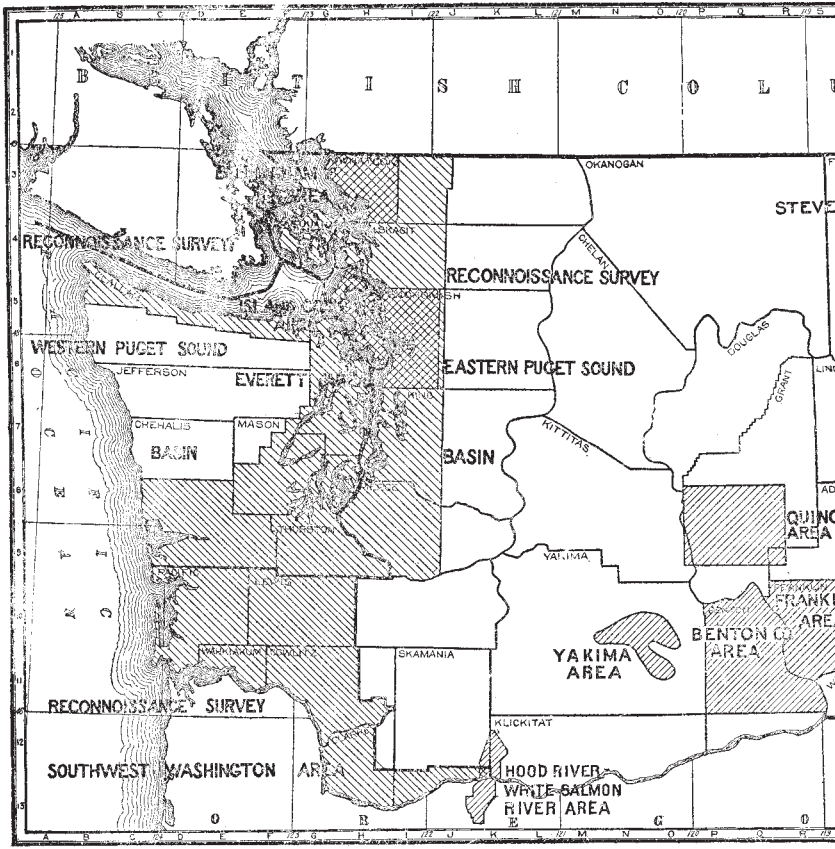
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]



Areas surveyed in Washington.

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U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP
SPOKANE COUNTY–NORTHERN SHEET
WASHINGTON

STATE OF WASHINGTON
ERNEST LISTER, GOVERNOR
HENRY LANDIS, STATE GEOLOGIST

CONVENTIONAL SIGNS

CULTURE
(Printed in black.)

City or Village. Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort

Secondary roads and Trails
Railroads, Steam and Electric
Bridges, Ferry
R.R. crossings, Tunnel
Ford, Dam, Sawmill, Windmill
Boundary lines
School, Church, Creamery, Cemeteries
Boundary lines
Triangulation station, Boundary monument, Oil or Gas wells
U. S. Township and Section lines, Recovered corners
Forest fire station, Airway beacon, Oil or Gas tanks
Transmission line, Oil or Gas pipe line
Mine or Quarry, Rock outcrop, Made land
Soil boundaries, Stony, Gravelly and Cherty areas

RELIEF
(Printed in brown or black.)

Contours, Depression contours
Prominent Hills, Mountain peaks
Sand Wash and Sand dunes
Bluff, Escarpment, Mine dumps

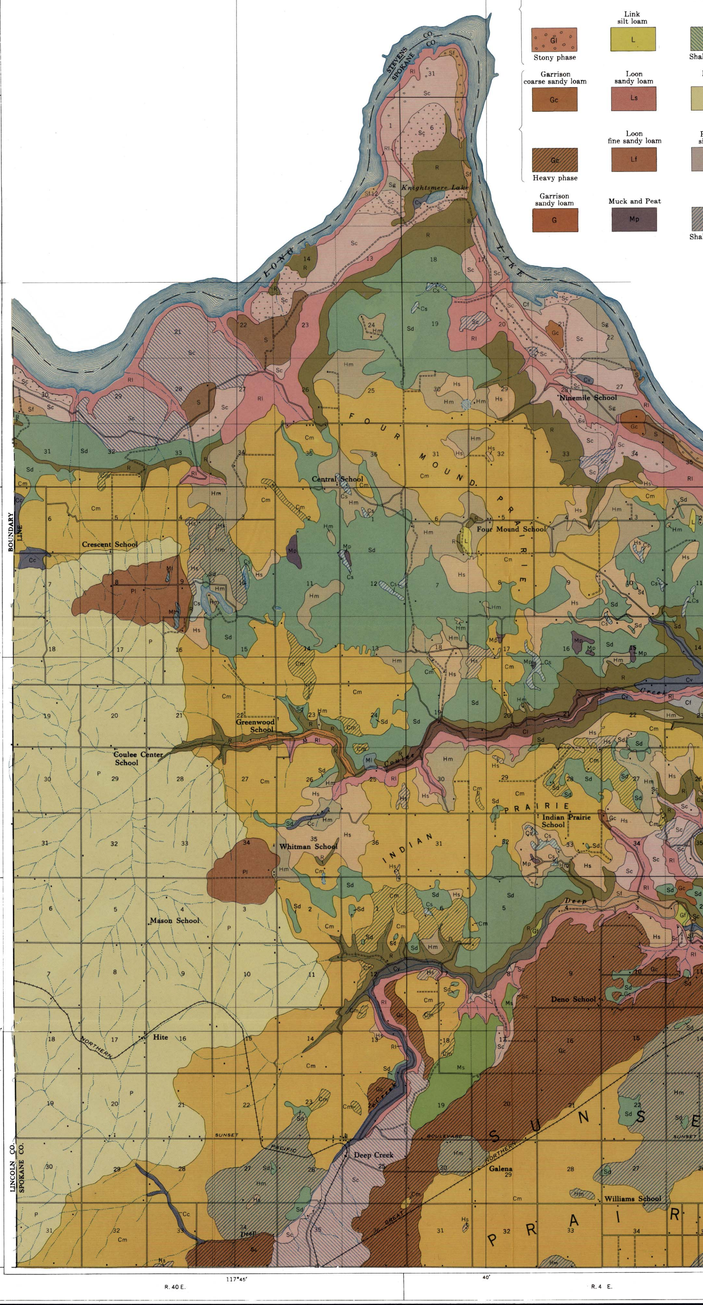
DRAINAGE
(Printed in blue.)

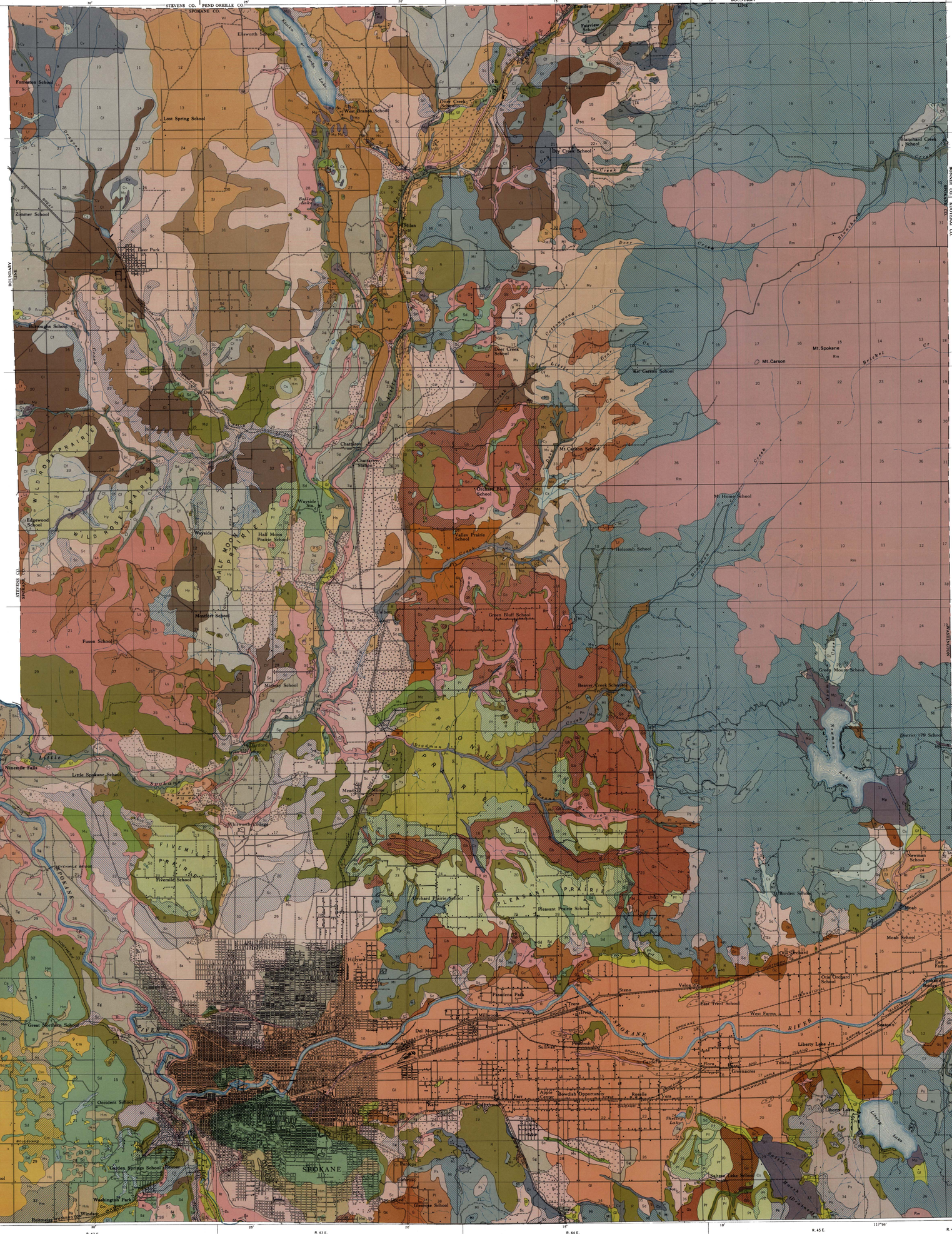
Streams, Springs, Wells, Flowing wells
Lakes, Ponds, Intermittent lakes
Unsurveyed and intermittent streams
Water pipe lines, Canals, Ditches, Flumes
Swamp, Salt marshes
Submerged marsh, Tidal flats

The above signs are correctly used on the soil maps, formations from this triangle appearing in some maps of another series.

LEGEND

Caldwell silty clay loam — Cc	Garrison fine sandy loam — Gf	Marble coarse sand — Ms	Peone silt loam — Pn
Cheney silt loam — Cm	Green Bluff loam — Gb	Marble sand — Md	Springdale gravelly loam — Sg
Shallow phase — Cm	Slope phase — Gb	Mission fine sandy loam — M	Springdale coarse sandy loam — Sc
Clayton sandy loam — Cl	Helmer silt loam — Ht	Mission silt loam — Mo	Rolling phase — Sc
Clayton fine sandy loam — Cf	Hesseltine stony loam — Hs	Moscow very coarse sandy loam — Mv	Light phase — Sl
Rolling phase — Cf	Treeless phase — Hs	Moscow loam — Ml	Gravelly phase — Sc
Clayton very fine sandy loam — Cv	Hesseltine loam — Hm	Heavy-subsoil phase — Ml	Springdale sandy loam — S
Colville fine sandy loam Dark-subsoil phase — Cy	Treeless phase — Hm	Shallow phase — Ml	Springdale fine sandy loam — Sf
Colville silt loam — Cs	Huckleberry gravelly loam — Hl	Palouse sandy loam — Pl	Stony phase — Sf
Dark-subsoil phase — Cs	Hunters fine sandy loam — Hy	Palouse fine sandy loam — Pf	Underwood loam — Ul
Garrison gravelly loam — Gl	Hunters very fine sandy loam — Hf	Slope phase — Pf	Waits stony loam — Ws
Stony phase — Gl	Link silt loam — L	Shallow phase — Pf	Waits silt loam — Wl
Garrison coarse sandy loam — Gc	Loon sandy loam — Ls	Palouse loam — P	Rough broken land — Rl
Heavy phase — Gc	Loon fine sandy loam — Lf	Palouse silt loam — Ps	Rough stony land — R
Garrison sandy loam — G	Muck and Peat — Mp	Shallow phase — Ps	Rough mountainous land — Rm
			Scabland — Sd





R. 40 E. 117°45' 40' R. 41 E. 35' 30' R. 42 E. 25' 20' R. 43 E. 15' R. 44 E. 10' R. 45 E. 117°00' R. 46 E.

T. 29 N. 48°00' T. 28 N. 55' 50' T. 27 N. 45' T. 26 N. 40' T. 25 N.

Macy H. Lapham, Inspector Western Division.
Soils surveyed by Cornelius Van Duyne, in charge, and H. C. Mortlock, of the U. S. Department of Agriculture, and A. F. Heck, and E. D. Alvord of the Washington Geological Survey.

1 ½ 0 1 2 3 4 Miles
Scale 1 inch = 1 mile

Field Operations
Bureau of Soils
1917

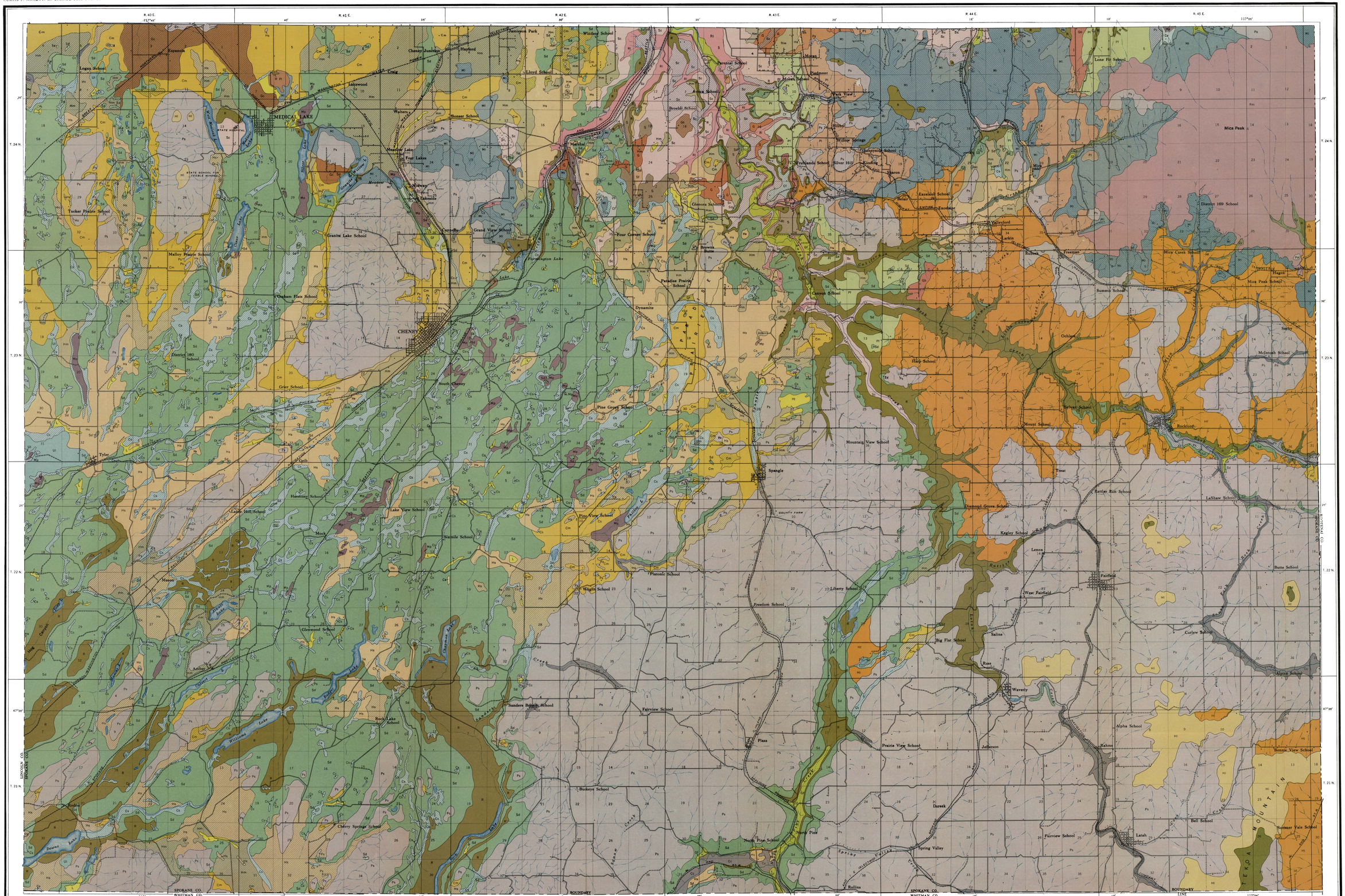
U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP

SPOKANE COUNTY—SOUTHERN SHEET

WASHINGTON

STATE OF WASHINGTON
ERNEST LISTER, GOVERNOR
HENRY LANDIS, STATE GEOLOGIST



LEGEND

- Caldwell silty clay loam — Cc
- Cheney silt loam — Cm
- Cheney silt loam, Shallow phase — Cm
- Clayton sandy loam — Cl
- Clayton fine sandy loam — Cf
- Clayton fine sandy loam, Rolling phase — Cf
- Clayton very fine sandy loam — Cv
- Colville fine sandy loam Dark-subsoil phase — Cy
- Colville silt loam — Cs
- Colville silt loam, Dark-subsoil phase — Cs
- Garrison gravelly loam — Gl
- Garrison gravelly loam, Stony phase — Gl
- Garrison coarse sandy loam — Gc
- Garrison coarse sandy loam, Heavy phase — Gc
- Garrison sandy loam — G
- Garrison fine sandy loam — Gf
- Green Bluff loam — Gb
- Green Bluff loam, Slope phase — Gb
- Helmer silt loam — Ht
- Hesseltine stony loam — Hs
- Hesseltine stony loam, Treeless phase — Hs
- Hesseltine loam — Hm
- Hesseltine loam, Treeless phase — Hm
- Huckleberry gravelly loam — Hl
- Hunters fine sandy loam — Hy
- Hunters very fine sandy loam — Hf
- Link silt loam — L
- Loon sandy loam — Ls
- Loon fine sandy loam — Lf
- Muck and Peat — Mp
- Marble coarse sand — Ms
- Marble sand — Md
- Mission fine sandy loam — M
- Mission silt loam — Mo
- Moscow very coarse sandy loam — Mv
- Moscow loam — Ml
- Heavy-subsoil phase — Ml
- Shallow phase — Ml
- Palouse sandy loam — Pl
- Palouse fine sandy loam — Pf
- Slope phase — Pf
- Shallow phase — Pf
- Palouse loam — P
- Palouse silt loam — Ps
- Shallow phase — Ps
- Palouse silt loam — Pn
- Springdale gravelly loam — Sg
- Springdale coarse sandy loam — Sc
- Rolling phase — Sc
- Light phase — Sc
- Gravelly phase — Sc
- Springdale sandy loam — S
- Springdale fine sandy loam — Sf
- Stony phase — Sf
- Underwood loam — Ul
- Waits stony loam — Ws
- Waits silt loam — Wl
- Rough broken land — Rl
- Rough stony land — R
- Rough mountainous land — Rm
- Scabland — Sd

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